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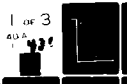

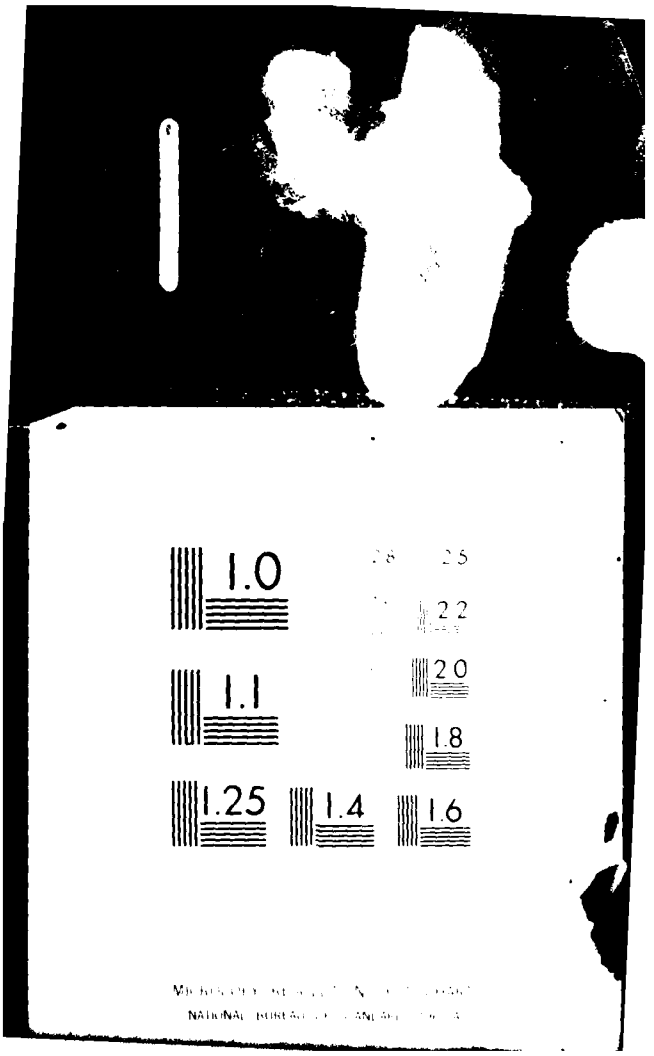
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MAINTENANCE TRAINING SIMULATOR DESIGN AND ACQUISITION: HANDBOOK OF ISD PROCEDURES FOR DESIGN AND DOCUMENTATION

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The Public Affairs Office has reviewed this paper, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This paper has been reviewed and is approved for publication.

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This technical paper presents a method for deriving training requirements, selecting an approach for meeting the training objectives identified, and making training equipment fidelity and instructional feature design decisions where training hardware is needed. The procedures supplement existing materials (AFP 50-58, and the 3300th Test and Evaluation Squadron Procedural Handbook, Edwards AFB) by clarifying existing training technology and providing new procedures to assist the ISD analyst in designing and documenting training equipment. The handbook expands upon currently used procedures in three major decision areas. These are (a) determining which training requirements require hardware or training equipment of some type, (b) selecting the degree of fidelity with which to represent components and parts on the training equipment, and (c) choosing instructional features to be incorporated

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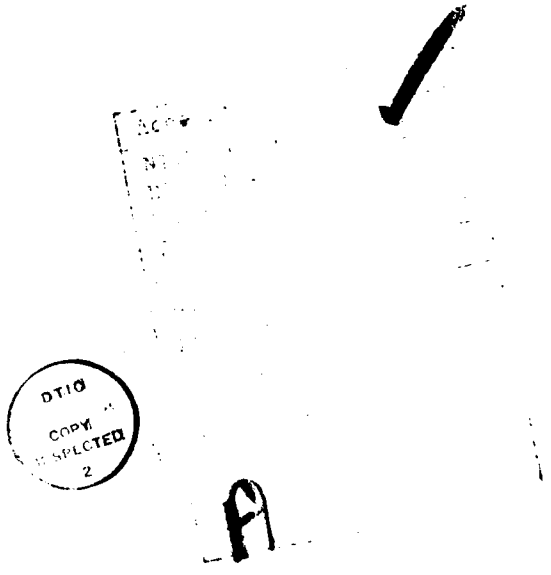
in the training equipment. All procedures are decision flow charts to increase objectivity.

The method results in documentation that is to be used as a basis for completing the ISD-Derived Training Equipment Design. The design is then communicated to the Simulator System Program Office (SimSPO) for use in preparing procurement specifications to contractors.



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PREFACE

This method for developing training was prepared by Applied Science Associates, Inc. (ASA), Valencia, Pennsylvania, under Air Force Contract No. F33615-78-C-0019. Mr George R. Purifoy, Jr. was the Principal Investigator and Project Director. The sponsor was the Technical Training Branch (at Lowry Air Force Base, Colorado) of the Logistics and Technical Training Division (at Wright-Patterson Air Force Base, Ohio) of the Air Force Human Resources Laboratory. Dr Edgar A. Smith was the Project Engineer.

This study is one of a series of related studies under Project 2361, Simulation for Maintenance Training. Project 2361 is an advanced development program to develop, demonstrate, test, and evaluate selected applications of computer-based simulation for Air Force maintenance training. The objective of this program is to build baseline knowledges about techniques, procedures, and principles necessary for broad applications of simulation in maintenance training. Simulator training devices are being fabricated and demonstrated in an operational training environment in order to establish cost, reliability, and training effectiveness information. These data will contribute to a determination of training value factors for eventual Air Force use.

This paper contains a method for deriving training requirements and making training equipment fidelity and instructional features design decisions. The method is to be used by the Instructional System Development (ISD) analyst(s) when the need for training has been identified. The method produces documentation for a training equipment design which can be communicated to the System Project Office (SPO) Training Equipment Acquisition Manager.

The authors wish to acknowledge the assistance and cooperation of the many individuals who contributed information and critiqued ideas. From ASA; the Staff of the Graphics Department; clerical personnel Lois Hill and Ruth Ruckdeschel.

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INTRODUCTION AND BACKGROUND

In 1973, the Air Force Chief of Staff directed that "ISD be applied to all new instructional systems... ." The Instructional System Development (ISD) process is an orderly and systematic approach for identifying the skills and knowledge that personnel need to be taught to ensure successful job performance. Prior to 1973, the main application of ISD was limited to existing resident training programs.

In 1975, the 3306th Test and Evaluation Squadron (TES) was formed at Edwards Air Force Base, California. Their mission, among other responsibilities, included the development of system maintenance training for new weapon systems using the ISD process in a test and evaluation environment. The established ISD process, as outlined in AFP 50-2 and AFP 50-58, required some modification to accommodate the peculiarities, benefits, and limitations of the test and evaluation environment. The 3306th TES adaptions of the ISD process appear in the 3306th Procedural Handbook (1979). The procedures in the 1979 version of the 3306th Procedural Handbook evolved over the years as experience was gained in applying ISD to new weapons systems.

The purpose of this Handbook is to supplement the procedures described in the 3306th Procedural Handbook and AFP 50-58. It is assumed that the user of this handbook is familiar with either or both of these documents. Reference is made to both documents in this Handbook and it is essential that the user have them available when reading the procedures discussed and presented here. No effort is made to duplicate or separate the information that is presented in the 3306th Procedural Handbook or AFP 50-58. Where procedures from either of these documents have been found useful, you are directed to them. It is not the purpose of this document to replace either AFP 50-58 or the 3306th Procedural Handbook.

The procedures presented in this Handbook concentrate on three major decisions that must be made when designing training equipment. First, an objective procedure is offered to identify which training requirements require hardware-type media (training equipment of some sort). The procedure offered is a further refinement of the procedures specified in the 3306th Procedural Handbook (1979). Secondly, an objective procedure has been developed to determine the degree of

fidelity of the components or parts (SRU, LRU, displays, dials, and controls) that are to be represented on the training equipment. Finally, a procedure has been developed to guide the decision of what instructional features are essential and must be incorporated in the training equipment. All the procedures use decision flow charts to increase objectivity. Forms and worksheets have been constructed to document all instructional decisions so that traceability is maximized.

The procedures described in this Handbook include a step for documenting the training equipment design which results from the ISD analysis. A model for the documentation of the design has been prepared. The model is an attempt to standardize the way the ISD-derived training equipment design is communicated to the Simulator System Program Office (SIMSPO). The model is written in a military specification/standard format and contains blanks to be completed by the ISD analysts. If the model is followed it will assure that training equipment designs are always communicated to the SIMSPO in the same fashion, since design requirements and/or information will always be located in some place within the communication document and will be stated in approximately the same way. The model can be viewed as a shopping list of possible design requirements, features, or characteristics. A specific application of the model, when submitted to SIMSPO, becomes a primary source for developing the specification that goes to contractors for bid. Thus, the ISD analyst should view the model for document training equipment designs as the specific output of the ISD procedure.

Brief Description of Procedures

The procedures described in AFP 50-58, the 3306th Procedural Handbook, and this supplemental Handbook, are summarized in Table 1 (page 3). As you can see, some of the steps in the 3306th Procedural Handbook are identical to the steps presented here, particularly Steps 10 through 14. Differences occur where the 3306th procedures were supplemented, reorganized, or reformatted to accommodate certain training considerations. The next paragraph briefly describes some of the differences.

Some of the steps in the 3306th procedures have been combined to form one step in the procedures presented here; for example, Steps 3 and 4 in the 3306th Procedural Handbook have been combined into a single Step (Step 2, Identify Characteristics of the Target Population). In addition, some of the steps in the 3306th Procedural Handbook are not separate steps in the procedures presented here, but are subsumed or incorporated into other steps. For example, Step 2

Table 1

SUMMARY OF PROCEDURES

AFP 50-58	3306th Procedural Handbook	Supplemental Handbook
1. Analysis of System Requirements	1. Identify System Maintenance Requirements	1. Identify System Maintenance Requirements
	2. Identify Abnormal Conditions and/or Unusual Criteria	2. Identify Characteristics of Target Population
	3. Determine Target Population	
	4. Identify Present Capabilities of Target Population	
2. Define Education or Training Requirements	5. Determine Training Requirements	3. Determine Training
	6. Develop Behavioral Requirements	4. Determine Type of Technical Training Materials (TTM) Required
	7. Determine how Training will be Accomplished (Formal Classroom and/or On-The-Job Training (OJT)	5. Sequence Skills and Knowledge (Utilization Plan)
3. Develop Objectives and Tests	8. Determine Technical Training Materials (TTM)	6. Identify Fidelity and Simulated Features
		7. Select Instructional Features
		8. Prepare ISD Specification
	9. Determine Best Method of Classroom Instruction	9. Identify Method
4. Plan, Develop, and Validate Instruction	10. Prepare Course Control Documents (CCDs)	10. Prepare Course Control Documents (CCDs)
	11. Prepare Instructional Materials and Tests	11. Prepare Instructional Materials and Tests
	12. Validate Instruction	12. Validate Instuctions
5. Conduct and Evaluate Instruction	13. Conduct Training	13. Conduct Training
	14. Evaluate Training	14. Evaluate Training

in the 3306th Procedural Handbook (Identify Abnormal Conditions and/or Unusual Criteria) has been incorporated into Step 3 of the supplemental Handbook procedures (Determine Training Requirements). In addition to identifying abnormal conditions and unusual criteria, Step 3 of the present procedures identifies instances of negative transfer and the use of new support equipment or tools. These additional considerations, particularly the negative transfer issue, dictated that the 3306th Step 2 be expanded and performed after the target population had been described; thus, Step 2 of the 3306th procedures was incorporated into Step 3 of the procedures presented here.

Furthermore, some of the steps in this supplemental manual are performed in a different sequence than specified in the 3306th Procedural Handbook; for example, Step 8 (Determine Technical Training Materials) is Step 4 of the procedures described in this document. It has been moved up in order to present a procedure for separating training requirements into two groups: those training requirements where hardware-type media (training equipment of some sort) are required and those where non-hardware media (sound/slide, visuals, computer assisted instruction, printed materials, etc.) are adequate.

Finally, some of the procedures presented in this supplemental Handbook have no analog in the 3306th procedures. These include: Step 5, Sequence Skills and Knowledge (Utilization Plan); Step 6, Identify Fidelity and Simulated Features; Step 7, Select Instructional Features; and Step 8, Prepare ISD-derived training equipment design document (called an ISD specification). These steps, although addressed in the 3306th Procedural Handbook in various degrees, have been further defined and expanded and are therefore listed as new steps.

The procedures presented in this document are summarized in Figure 1 (page 5). Steps 1, 2, and 3 are self-explanatory. At Step 4 (Determine Type of Technical Training Materials) training requirements are separated into those requiring training equipment of sort and those requiring non-hardware media. Step 5, the Utilization Plan, is then performed. In Step 5, an initial determination is made concerning how the skills and knowledge (training requirements) are sequenced and how the training equipment might be used. Step 5 is performed at this point because the sequencing of training requirements and the use of training equipment influences training equipment design decisions.

After Step 5, the procedure branches; a different path is followed for those training requirements requiring training equipment than for those requiring non-hardware media. Those training requirements requiring training equipment are then processed through Steps 6, 7, and 8. Those not using training equipment are processed through Step 9.

SUMMARY OF PROCEDURES

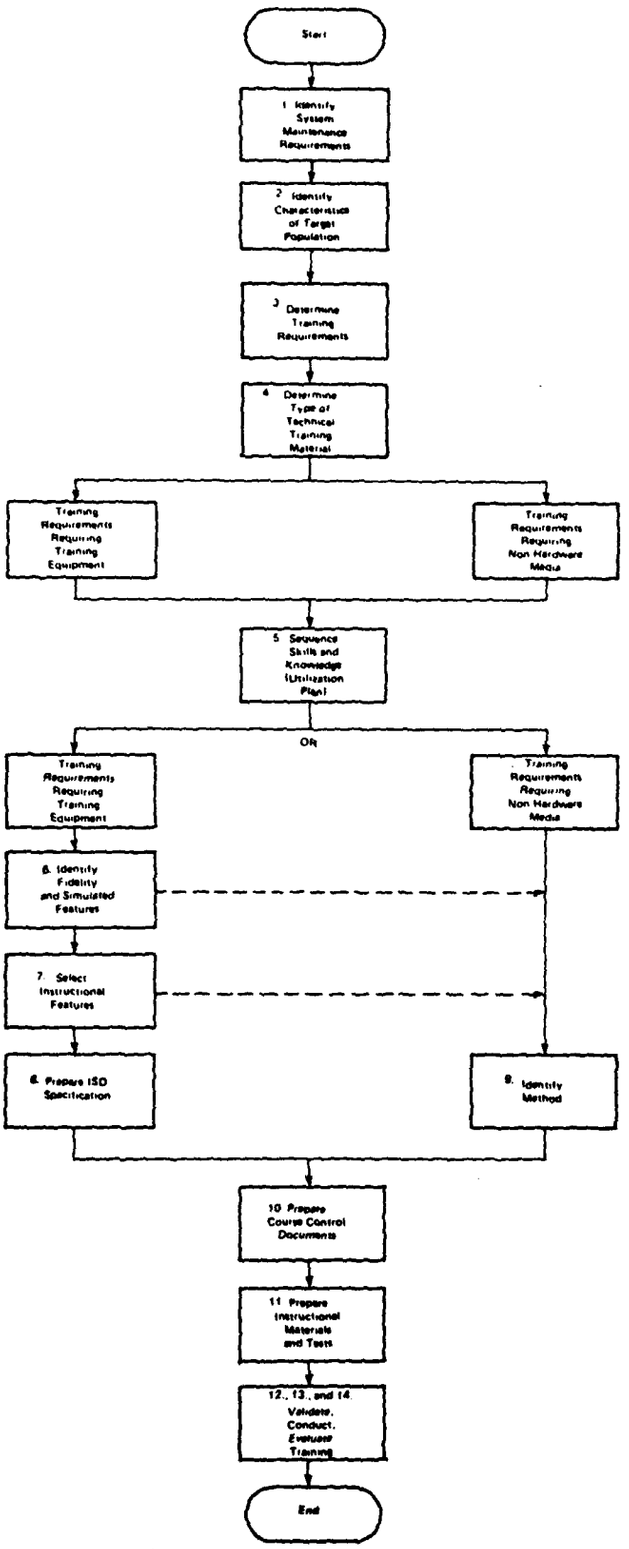


Figure 1. Summary of Procedures

The same procedure is then followed through Steps 10, 11, 12, 13, and 14 for both types of training requirements.

Limitations of the Procedures

There are several limitations to the procedures described in this document. Each of these is discussed in a paragraph below.

The procedures presented in this document are not paint-by-the-numbers procedures. The current state-of-the-art precludes the development of such procedures. The procedures try to introduce objectivity, but many of the decisions you will be making require a degree of expertise and knowledge on your part. For example, when deciding which training requirements require training equipment you are asked a series of questions (is the skill or knowledge difficult to learn, are hardware cues important, what are the consequences of an error, etc.). To help you answer these types of questions you are prompted and given guidance. However, you must apply your own experience and knowledge to determine the answers to such questions.

The procedures also do not lead you to a specific training equipment label. That is, the procedures do not output a mock-up, model, sophisicated simulator, or a familiarization trainer. The philosophy adopted is that labels are misleading and open to interpretation. The approach taken is for the procedure to output a required degree of fidelity for each component to be represented on the training equipment, that is, fidelity decisions are made separately based upon individual training requirements. Later, training requirements are grouped, but not necessarily by common fidelity decisions. The present state-of-the-art does not permit classification of training equipment into discrete categories according to the level of fidelity required. What is important is not the label given to the training equipment, but the degree of fidelity that each of the components must possess.

The procedures consider only certain instructional features; not all possible instructural features are discussed. That is, the procedure allows you to select instructional features from a pre-determined finite list of instructional features.

Finally, the procedures (not unlike other ISD procedures) are not clear cut or straightforward. ISD, in and of itself, is an iterative process. Decisions that are made early in the procedures may be changed at a later point. For example, in Step 4 skills and knowledge are identified. In later steps, as you are identifying the

level of fidelity, additional skills and knowledge may come to mind. Thus, as you go through the procedures you should not feel uncomfortable about returning to earlier steps.

Organization of Handbook

Each of the steps listed in Figure 1 (page 5) is presented in a separate chapter or section. In the beginning of each section, the step is introduced and briefly described. The introduction to each section spells out the purpose and goal of the step and points out how the step differs from the 3306th Procedural Handbook and AFP 50-58 procedures. Next, the substeps involved in carrying out the step are described and examples are given. Great care is taken to fully explain the flow charts, forms, and worksheets associated with each step.

As you use the decision flow charts you will become familiar with the decisions that have to be made. There is a tendency after having used the flow charts a few times, to disregard the flow charts and go directly to the worksheets and forms. However, you should resist this temptation. As you will discover, the flow charts make fine distinctions and add new dimensions to your decision-making process each time you use them, so you are encouraged to keep using them regardless of how familiar you feel you have become with them.

It should be pointed out that this Handbook was primarily written for inexperienced ISD analysts. An experienced analyst may see many shortcuts which, if used, would not degrade the quality of the decisions being made. For example, an ISD analyst with experience and familiarity with the 3306th Procedural Handbook might find it more convenient to go directly to Step 6 of the procedures, where fidelity decisions are made. It should also be mentioned that experienced ISD analysts might not find many of the decision-making procedures specified in this Handbook new; i.e., they may comment that they consider some of the same factors when making fidelity decisions or determining which training requirements should be acquired using the trainer. Indeed an experienced analyst should feel this way, because he should be considering such factors when making these decisions. This Handbook attempts to standardize the procedures and force the inexperienced analyst to consider the important factors

when making critical decisions. The Handbook, also attempts to present decision points and criteria in a logical fashion, thus helping the inexperienced analyst to take advantage of the mistakes made and lessons learned by experienced analysts.

- ■ STEP 1 Identify System Maintenance Requirements
- ☐ STEP 2 Identify Characteristics of the Target Population
- ☐ STEP 3 Determine Training Requirements
- ☐ STEP 4 Determine the Type of Technical Training Materials Required
- ☐ STEP 5 Sequence Skills and Knowledge (Utilization Plan)
- ☐ STEP 6 Identify Fidelity and Simulated Features
- ☐ STEP 7 Select Instructional Features
- ☐ STEP 8 Prepare ISD Specification
- ☐ STEP 9 Identify Method
- ☐ STEP 10 Prepare Course Control Documents (CCD'S)
- ☐ STEP 11 Prepare Instructional Materials and Tests
- ☐ STEP 12 Validate Instruction
- ☐ STEP 13/14 Conduct Training and Evaluate Training

STEP 1. IDENTIFY SYSTEM MAINTENANCE REQUIREMENTS

The first step in any ISD effort is to determine what people must do to make the operational system work; that is, to identify the duties, tasks, and subtasks that must be performed on the system.

Identifying system requirements consists of the substeps below. Since these substeps are described in the reference cited below, they will not be detailed in this handbook, except for Substeps 6 and 7.

Substep 1. Gather Available Data (AFP 50-58, Volume II, Chapter 2, pages 2-2 to 2-7; 3306th Procedural Handbook, Chapter 2, pages 18 to 20).

Substep 2. Identify Duties (AFP 50-58, Volume II, Chapter 2, pages 2-8 to 2-9; 3306th Procedural Handbook, Chapter 2, pages 18 to 20).

Substep 3. Identify Tasks (AFP 50-58, Volume II, Chapter 2, pages 2-10 to 2-12; 3306th Procedural Handbook, Chapter 2, page 20).

Substep 4. Identify Subtasks (AFP 50-58, Volume II, Chapter 2, pages 2-12 to 2-16; 3306th Procedural Handbook, Chapter 2, pages 57-58).

Substep 5. Verify the Task List (AFP 50-58, Volume II, Chapter 2, page 2-16; 3306th Procedural Handbook, Chapter 2, page 22).

Substep 6. Group Tasks (AFP 50-58, Volume II, Chapter 2, pages 2-14 to 2-16; 3306th Procedural Handbook, Chapter 2, pages 22 to 24).

Substep 7. Record Task Statements for Further Analysis (AFP 50-58, Volume II, Chapter 2, pages 2-20 to 2-47; 3306th Procedural Handbook, Chapter 2, pages 47 to 67).

If you are working on an existing system you should follow the procedures referenced in AFP 50-58 beside each substep above, except

for substeps 6 and 7. If you are working on a new weapons system you should follow the procedures referenced in the 3306th Procedural Handbook, except for substeps 6 and 7. Substeps 6 and 7 are discussed below.

Substep 6. Grouping Tasks

The way tasks in which are grouped influences the design of training equipment. Tasks that are grouped together tend to be taught together, as well as taught using the same class or type of media. A logical procedure for grouping tasks is to first aggregate all the tasks performed on the same equipment system. The tasks related to a particular equipment system may then be separated according to the equipment function to which they pertain. Finally, tasks may be broken down into groups according to procedures within each function of an equipment system. Typically tasks such as the following will form a procedural group:

- Preventive Maintenance (PM) Tasks.
- Operational Checks Tasks.
- General Inspection Tasks.
- Align and Calibrate Tasks.
- Fault Detection Tasks.
- Fault Isolation (Troubleshoot) Tasks.
- Remove and Replace Units Tasks.

For example, all tasks performed on radar system equipment should be grouped together. Hydraulic system tasks would form another such group. System tasks should then be separated according to the function which they relate to. All the radar system tasks related to "Signal Amplification" should form one group, while "Image Generation" tasks should compose another tunctional group. Finally, the tasks should be divided according to procedure. Under the system function "Signal Amplification" each of the following tasks would belong to a different procedural grouping: Inspect unit XYZ," "Calibrate unit WMT," "Isolate malfunctions," "Remove and replace unit TNZ," etc.

Grouping tasks by procedure will make it easier for you to make fidelity decisions. Fidelity decisions are made for the components or parts that are used in a task. If the tasks are grouped by procedure (and also by function and equipment system), it is likely that all the tasks within the procedure will involve the same components or parts. Thus, the components or parts will be easier to identify and document.

Substep 7. Recording Task Statements

Because the documentation and forms used here are different than those used in AFP 50-58 or the 3306th Procedural Handbook, those procedures cannot be used to record the task statements. However, task statements should be phrased as indicated in either AFP 50-58 (Volume II, Chapter 2, page 2-10 to 2-11) or in the 3306th Procedural Handbook (Chapter 2, pages 25 to 27). Recording task statements involves completing only Blocks 1 to 8 on FORM 1 (see Figure 2, page 12). A block by block description follows. A completed FORM 1 appears in Figure 3 (page 14). Each task identified should be recorded on a FORM 1. If logistical support analysis (LSA) data is available, you may elect to complete a FORM 1 only for those tasks which are not recorded or reported on an LSA.

Block 1. TASK/SUBTASK NUMBER: Circle either task or subtask indicating the type of unit of work that is being recorded. Next enter the task number. The task number is important and is used to trace your instructional decisions. You should follow the numbering procedure in the 3306th Procedural Handbook (Chapter 2, pages 57 and 58).

Block 2. TASK/SUBTASK TITLE: Enter the task or subtask title. This is a narrative description of the overall task that the maintenance specialist must perform. It should be phrased following the standards given in the 3306th Procedural Handbook or AFP 50-58.

Block 3. INITIALS: Enter your initials.

Block 4. DATE: Enter the preparation date on the form.

Block 5. PAGE: Indicates the number of FORMS 1 associated with this task. Leave the space after the "of" blank until another page is used.

Block 6. WUC: Enter the WUC (Work Unit Code) whose steps/activities are similar to the task identified in Blocks 1 and 2.

Block 7. AFSC: Enter the AFSC that is expected to be prime for performing the task. You do not have to designate the skill level.

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE C =

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	

Form 1

Figure 2. FORM 1

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4 DATE	5. PAGE OF
XXXX01	INSTALL CDU	RJH	09-15-80	1 1

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	XXXX	T.O. 45Z520, Page 402

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	

Form 1

Figure 3. FORM 1, Task Statements

Block 8. ADDITIONAL INFORMATION SOURCES AND DATE: List all sources used to identify the task or subtask; for example, blueprints, interviews with maintenance crews or engineers or over-the-shoulder evaluations by ATC SME. If blueprints were used, give the number and date of blueprints. If personal interviews were a source, give names and dates. Enter the LSA title and/or number which was used to identify this task. If possible enter (in parentheses) the LSA page number where the task is described. This will be an easy reference to track the task and will minimize the amount of recording and writing that you will have to do. You should update this block as information sources are used.

☐ STEP 1	Identify System Maintenance Requirements
■ STEP 2	Identify Characteristics of the Target Population
☐ STEP 3	Determine Training Requirements
☐ STEP 4	Determine the Type of Technical Training Materials Required
☐ STEP 5	Sequence Skills and Knowledge (Utilization Plan)
☐ STEP 6	Identify Fidelity and Simulated Features
☐ STEP 7	Select Instructional Features
☐ STEP 8	Prepare ISD Specification
☐ STEP 9	Identify Method
☐ STEP 10	Prepare Course Control Documents (CCD'S)
☐ STEP 11	Prepare Instructional Materials and Tests
☐ STEP 12	Validate Instruction
☐ STEP 13/14	Conduct Training and Evaluate Training

STEP 2. IDENTIFY CHARACTERISTICS OF THE TARGET POPULATION

(This step is a combination of Steps 3 and 4 specified in the 3306th Procedural Handbook, page 30). Before you can specify training requirements, you need two sources of information. First, you need to know the duties, tasks, and subtasks that are to be performed to keep your system operational (these were determined in Step 1). Second, you need to become familiar with the characteristics of those students who are to be trained (that is the purpose of this step). To specify training requirements you need to know what skills can already be performed and what knowledge is already possessed by the student who will enter your training. Training Requirements are specified by subtracting what the entering students already know and can do from what they need to know and do to keep your system operational. If you describe the characteristics of the target population inaccurately, the results of your subtraction will be inaccurate and you will have identified inappropriate training requirements. Errors in this step rebound through the whole instructional decision-making process. In fact, if you describe the target population inaccurately, you will have to redo the remaining steps in the ISD procedures.

AFP 50-58 offers little advice in defining the target population. The 3306th Procedural Handbook (Chapter 2, page 30, paragraphs 3 and 4) states that, at a minimum, you should specify the AFSC of the entering students as well as any previous weapons experience that the target population might have. To become familiar with the skills and knowledge the target population already possesses, you should review these sources: course training standards, specialty training standards, occupational surveys, and your own experience in dealing with the entering AFSC.

If the target population has known previous weapons experience, then you should familiarize yourself with these weapons systems. The more familiar you are with the characteristics of the target population the more accurately you can make training decisions.

In the next step, you will be asked critical questions about the target population and their ability to perform the task under consideration. Your answers will greatly influence the content of your training program as well as the type of training equipment that might be needed, so learn as much as you can about the target population before proceeding.

☐	STEP 1	Identify System Maintenance Requirements
☐	STEP 2	Identify Characteristics of the Target Population
■	STEP 3	Determine Training Requirements
☐	STEP 4	Determine the Type of Technical Training Materials Required
☐	STEP 5	Sequence Skills and Knowledge (Utilization Plan)
☐	STEP 6	Identify Fidelity and Simulated Features
☐	STEP 7	Select Instructional Features
☐	STEP 8	Prepare ISD Specification
☐	STEP 9	Identify Method
☐	STEP 10	Prepare Course Control Documents (CCD'S)
☐	STEP 11	Prepare Instructional Materials and Tests
☐	STEP 12	Validate Instruction
☐	STEP 13/14	Conduct Training and Evaluate Training

STEP 3. DETERMINE TRAINING REQUIREMENTS

This is the first major instructional decision-making step in the ISD process. In this step you will decide what is and what is not to be included in your training program. This decision is made by subtracting the results of Step 2 from the results of Step 1. That is, this decision is made by comparing the system maintenance requirements identified in Step 1 with the characteristics of the target population identified in Step 2. If the target population can already meet a system maintenance requirement, then that requirement need not be included in your training program. If the target population cannot meet the requirement, then they must be taught the skills and knowledge associated with that job requirement.

AFP 50-58 (Volume II, Chapter 3) and the 3306th Procedural Handbook (Chapter 2, pages 31 to 52) discuss the identification of training requirements. Basically the procedures consist of: (a) identifying the skills and knowledge associated with each task or subtask and (b) identifying what skills and knowledge need to be taught or included in your training program. This approach is maintained here, however, the procedures have been slightly modified. The modifications involve the cycle that is used to identify tasks, steps/activities within tasks, and skills and knowledge within tasks which contain potential training requirements. The procedures in AFP 50-58 and the 3306th Procedural Handbook require you to identify the the steps/activities of every task and the skills and knowledge associated with every step/activity. The procedures below are designed to eliminate steps/activities and skills and knowledge early in the cycle; thus, reducing the amount of work you must perform. For example, if a step/activity can be eliminated, there is no need for you to identify the skills and knowledge associated with the step/activity.

In addition, the questions which are asked to determine if a step/activity has the potential to contain a training requirement, have been modified. Because the set of questions you asked is used to eliminate steps/activities from your training program, this set of questions is critical. The questions asked are:

A. Is the step/activity <u>new</u> to the target population?

B. Are there any <u>abnormal conditions</u> associated with the step/activity?

C. Are there new or unusual criteria related to the step/activity)?

D. Is there a chance for negative transfer to occur?

E. Are any new support tools or equipment used?

F. If none of the above requirements are indicated, then does the step/activity have to be integrated with other steps/activities?

The answers to these questions are dependent upon your knowledge of the target population (Step 2). As you will see, a "Yes" answer to any of the questions means the step/activity contains a potential training requirement.

Finally, the procedure for identifying skills and knowledge (training requirements) has been changed. The procedures discussed in AFP 50-58 (Volume II, Chapter 3, pages 3-10 to 3-22) and the 3306th Procedural Handbook (Chapter 2, pages 43 to 47) mix the identification of skills and knowledge with the decision to include the skill or knowledge in your training program. The procedures below separate these decisions. First you will identify the skills and knowledge, then you will ask yourself a set of questions to determine if the skill or knowledge should be included in your training program. A new *taxonomy* is introduced to help you identify skills and knowledge.

A section has also been added to deal with documenting and identifying skills and knowledge for troubleshooting tasks.

The substeps involved in Step 3 are:

Substep 1. Identify the steps/activities of each task.

Substep 2. Select steps/activities that potentially contain a training requirement.

Substep 3. Identify the skills and knowledge associated with each step/activity potentially containing a training requirement, and the task as a whole.

Substep 4. Select those skills and knowledge to be included in your training program.

As you will see, the procedures for accomplishing Substeps 2 and 4 are very similar. These substeps are described in greater detail below.

Substep 1. Identify the Steps/Activities of Each Task

The purpose of this substep is to document the steps/activities involved in each task. If the task title indicates a malfunction detection or isolation behavior, go to page 39. Malfunction tasks need to be recorded or documented in a different manner.

This substep is very important, as the steps/activities are analyzed to determine the skills and knowledge to be included in your training program. To identify the steps/activities comprising your task, use any and all task data available to you (TOs, the LSA, personal experience, interviews with test personnel, etc). All sources used to initially identify the task as a system maintenance requirement should be reviewed before listing the steps/activities on FORM 1.

List each step/activity involved in the task under Column 10, of FORM 1. Be sure to indicate the step/activity number in Column 9. For each step/activity, as a minimum identify or describe:

A. The action taken; you should try to use one of the action verbs listed in skill and knowledge taxonomy, Table 2, page 22.

B. The object the action is directed toward (equipment, LRU, SRU, etc.).

C. The equipment or tools used to perform the action (be sure to include test equipment).

D. Any precautions and likely errors (common errors); also include error correction activities or error recovery procedures, if appropriate. You may even want to make the recovery procedures a separate subtask.

E. Any alternative procedures or steps/activities.

F. Any contingencies that might exist; if the step/activity requires a decision to be made, be sure to describe the inputs needed to make that decision.

Table 2

SKILL AND KNOWLEDGE TAXONOMY

TAXONOMIC CODE	DEFINITION AND EXAMPLE	ACTION VERBS FOR SKILLS AND KNOWLEDGE
(ASO)	1. ASSOCIATING--Associating, naming, or responding to a specific input. The person associates a response with a specific input only. The response may be vocal, subvocal, written, or motor. EXAMPLE: Naming objects or events, identifying parts of equipment, as in locating AC power cord.	ASSOCIATE--to join or combine things or thoughts; to link or correlate. IDENTIFY, RELATE, NAME, MATE, MATCH, INDICATE, LABEL, LOCATE.
(RFP)	2a. RECALLING FACTS & PRINCIPLES -- Remembering and maintaining knowledge or nomenclature, functions and physical laws. Restating basic knowledge through mental rehearsal or verbal or written recall. *EXAMPLE:* Recalling specific radio frequencies; listing equipment parts, stating Ohm's law.	RECALL--to bring back to mind or summon from memory. ENUMERATE, (RE)STATE, RECITE, REITERATE, ITEMIZE, QUOTE, REPEAT.
(RPR)	2b. RECALLING PROCEDURES--Recalling sequences of required behaviors in a specified order. *EXAMPLE: Recalling check-out procedures* or assembly/disassembly routines.	(Same verb list as 2a).
(DIS)	3. DISCRIMINATING--Being able to distinguish between inputs. Making different responses to the different members of a particular class. EXAMPLE: Telling the difference between similar gauges on an instrument panel. Noticing frayed wiring.	DISCRIMINATE--to mark the peculiar features of; to recognize as being different from others. DETECT, COMPARE, DISTINGUISH, DIFFERENTIATE, SELECT.
(CLS)	4. CLASSIFYING--Recognizing patterns; seeing the similarity among a class of objects or events which call for a common response; generalizing. EXAMPLE: Aircraft classification (friendly, enemy, tactical, etc.)	CLASSIFY--to arrange in groups according to common characteristics; to assign systematically; show sameness or unity of. GROUP, SORT, CATEGORIZE, RANK, RATE, ASSIGN, FILE.
(RUS)	5. RULE USING--Applying a rule to a given situation by responding to a class input with a class of actions. Relating to two or more simpler concepts in the manner of a rule. A rule states the relationships among concepts. It is helpful to think of principles as "if - then" statements. *EXAMPLE: If the signal* indicator flashes, then lower pressure in the pump.	APPLY--to put into practice. CONVERT, CALCULATE, PREDICT, PRESCRIBE, TRANSLATE, TRANSCRIBE, VALIDATE, VERIFY.
(PBS)	6. PROBLEM-SOLVING--Making a decision based on limited information. Solving a novel problem by combining previously learned rules or generating new rules through trial-and-error. EXAMPLE: Isolating the sources of a malfunction.	SOLVE--to find an answer or remedy for. DIAGNOSE--to ascertain through examination and evaluation of symptoms. STUDY, ANALYZE, ADAPT, CREATE, DEVELOP, DEVISE.
(PSM)	7a. POSITIONING & SERIAL MOVEMENT-- Positioning switches, pushbuttons, knobs, levers, etc., either individually or in a chain of highly coordinated motor tasks. May require precision. Motor aspects of equipment set-up and operating procedures. EXAMPLE: Following equipment turn-on procedures; typing; switch-throwing.	POSITION--to fix in place; the state of being set in relation to others. ALIGN, INSERT, TURN ON/OFF, (DE)ACTIVATE, TUNE, (DIS)ENGAGE. *
(CMV)	7b. CONTINUOUS MOVEMENT--Perceptual-motor skills involving continuous pursuit of a target or keeping dials at a certain reading. Involves smooth eye-hand coordination and control. Compensatory movements based on feedback from displays. May involve scanning of complex displays to determine current status of system and to predict the evolving state of the system. EXAMPLE: Steering on a constant course, tracking.	TRACK--to follow closely on a regular course. TRACE, STEER, SLIDE, GUIDE. *
(RMV)	7c. REPETITIVE MOVEMENT (MANIPULATIONS)-- Repetitive or standardized behaviors, mechanical skills. Emphasizes dexterity, occasionally strength and endurance, requires low level of operator attention. Often a component of a larger task. EXAMPLE: Use of hand tools such as a hammer or wrench and *power tools such as* a drill press.	ASSEMBLE--bring together into operative whole. DISASSEMBLE, LUBRICATE, GRASP, MEASURE, (DIS)CONNECT, CUT, SPLICE, TIGHTEN/LOOSEN, HOLD, DRILL. *

*Shared motor taxonomy verbs: PRESS, PULL, REMOVE/REPLACE, EXTEND/RETRACT, LIFT/LOWER, CLEAN, INSTALL.

Documenting the task description can be a laborious process. It will require a lot of writing. To minimize the writing involved, you may find it convenient to reference TOs or LSAs rather than listing or describing each step/activity. However, if you do this be sure the steps/activities are accurately described in the TO or LSA. That is, be sure that the information requested in A through F above is included.

When describing the steps/activities, you should also describe certain information pertaining to the whole task, such as how the performer knows when the task is to be done (the precipitating input or conditions) and the output of the task if it is not obvious (these can be recorded at the beginning or the end of the list of steps/activities).

An example of step/activity FORM 1 documentation appears in Figure 4 (page 24). After you have recorded the steps/activities, you are ready to decide which of the steps/activities contain training requirements.

Substep 2. Select Steps/Activities That Potentially Contain a Training Requirement

It is conceivable that some of the steps/activities identified above can be performed by the target population. If this is the case, then these steps/activities need not be analyzed to identify the associated skills and knowledge. The procedure for identifying which steps/activities contain training requirements involves asking a set of questions for each step/activity of the task. The procedure is given in Figure 5, (page 25). Documentation of the decision is provided in Column 11 on FORM 1. The questions being asked are:

A. Is the step/activity new?

B. Are there any abnormal conditions associated with performing the step/activity?

C. Are there new or unusual criteria related to this step/activity?

D. Is there a chance for negative transfer to occur?

E. Are any new support tools required?

F. If none of the above requirements are indicated, then note as an "integration only" requirement.

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XXXX01	INSTALL CDU	RJH	09-L-80	1 1

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	XXXX	T.O. 452520, Page 402

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	
1	Remove cap plugs from CDU connectors.							
2	Set mode select switch to "off" position (see subtask xxxx02).							
3	Connect aircraft wiring connector 32A to CDU connector J1; secure by rotating counter clockwise. This connector must be connected first.							
4	Connect aircraft wiring connector 325X to CDU connector J2; then secure by rotating ring clockwise.							
5	Ensure CDU is rightway up, then install in Panel x22 and secure with 4 turn locks. Right side up is indicated with an X.							

Form 1

Figure 4. FORM 1 Example: Step/Activity Identification.

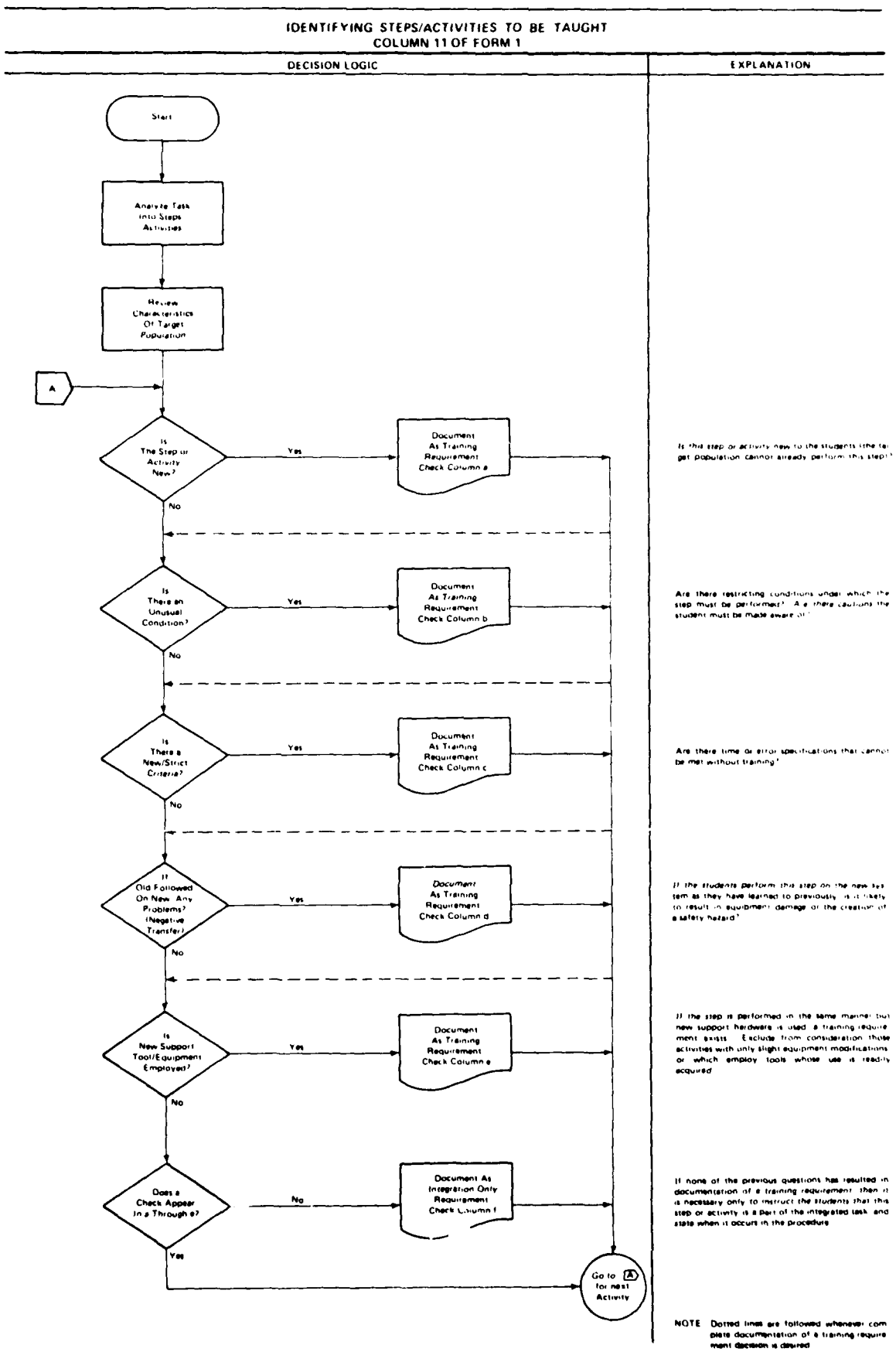


Figure 5. Identifying Steps/Activities to be Taught, Column II of FORM 1

Let's go through an example. For each step/activity you would ask yourself the questions specified in the flow chart. The flow chart can be used in two ways. One alternative is to follow the flow chart only until the first "Yes" answer is obtained. This answer can then be recorded on FORM 1. The first "Yes" answer indicates that the step/activity is a training requirement. The second alternative is used if you want a complete documentation of the reasons for specifying a training requirement. In this instance you would follow the dashed lines on the flow chart. The dashed lines force you to ask every question on the flow chart. This latter approach allows you to completely document every decision concerning the task; that is, it provides you with a documentation of every "Yes" answer.

Suppose the task of concern is "Install CDU (Control Display Unit)." Further suppose the target population has had some experience in doing this. We would review the task step/activity statements and maintenance manual 452520, page 402, where the task is described. Bearing in mind the characteristics of the target population, we would then ask ourselves, "Is the step/activity new?" A "Yes" answer would mean that the step/activity must be taught, since it is entirely new to everyone. Our "No" answer, however, does not mean that a training requirement does not exist. Since the task is performed on an existing system some data might be available on the task. At this point we would follow the procedure in AFP 50-58 (Volume II, Chapter 2, pages 2-16 to 2-19), which specifies the sources to examine to find task data such as frequency of performance, task criticality, learning difficulty, and consequences of inadequate performance. A review of these sources will aid in answering the remaining questions which are designed to identify whether in fact there is something different or more difficult when performing the steps/activities of the task in the existing system than in the new system. The step/activity may be performed on the new system in an awkward position (a position not required in the existing system) or in the new system it may be important for the cables to be connected in a specified order (not a requirement in the existing system). Either one of these situations would indicate that the students have to be taught something; that is, that a training requirement exists.

For purposes of illustration let's suppose that in the new system the cables must be connected in a specific order. This situation would require us to answer "Yes" for step/activity 3 to the question, "If procedures for the existing ("old") system are followed on the new system might problems result?" The "Yes" indicates that students must be retrained and taught the order in which the cables are connected. This is a situation of negative transfer; that is, a situation in which the new learning is going to be hampered by old habits.

In our example, all questions would be answered "No" for steps/activities 1, 2, 4, and 5. This would indicate that these steps/activities do not contain any training requirements, but must be integrated into the training. By integration, we mean the steps/activities must be mentioned as to where they occur, but not purposefully taught. Step/Activity 3 on the other hand, contains the instance of negative transfer described and therefore must be taught. There is something different (order of cable connection) in the new system which requires the student to practice the step/activity. Thus all the questions on the flow chart would be answered "No" except the negative transfer question for this step/activity. These decisions lead us to a documentation of the task as seen in Figure 6 (page 28).

You are now in a position to identify the skills and knowledge associated with each step/activity. This only needs to be done for those steps/activities where there is a check in a through e of Column 11, on FORM 1. That is, only for those steps/activities which contain potential training requirements.

Substep 3. Identify Skills and Knowledge for Each Step/Activity Potentially Containing a Training Requirement and the Tasks as a Whole

At this point you have described the tasks and you have identified which of the steps/activities contain specific training requirements. The next operation is to identify the skills and knowledge associated with each step/activity that contains a training requirement; that is, that has a check entered in Columns a through e in Column 11 on FORM 1. Identifying the skills and knowledge is the most critical substep within this step. The skills and knowledge you identify will form the foundation of your training program. They also influence the nature and type of training equipment that must be selected, so you must be very deliberate, precise, and careful when doing the analysis.

There are several types of skills and knowledge which need to be identified; there are those skills and knowledge that are associated with each step/activity, and there are those skills and knowledge that are associated with the task as a whole. First you will identify the knowledge associated with the step/activity. Next, you will identify the skills associated with the step/activity. Finally you will identify both the skills and knowledge associated with the total task.

1. (TASK) SUBTASK NUMBER	2. (TASK) SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XXXX01	INSTALL CDU	RJH	09-15-80	1 1

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	XXXX	T.O. 452520, PAGE 402

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12 COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	
1.	Remove cap plugs from CDU connectors.						✓	
2	Set mode select switch to "off" position (see subtask xxxx02).						✓	
3	Connect aircraft wiring connector 32A to CDU connector J1; secure by rotating counter clockwise. This connector must be connected first.				✓			order of connection is important
4	Connect aircraft wiring connector 325X to CDU connector J2, then secure by rotating ring clockwise.						✓	
5	Ensure CDU is rightway up, then install in panel X21 and secure with 4 turn locks. Right side up is indicated with an X.						✓	
								Task is performed when ordered by supervisor. Unit is not checked when installed- this is task XXXX05.

Form 1

Figure 6. FORM 1 Example: Steps/Activities to be Taught

Skills and knowledge are recorded on a separate form, "OJT" (see Figure 7, page 30). Complete Blocks 1 to 7 on "OJT" 2 in the same procedures as you used to complete Blocks 1 to 8 on "OJT" 1 (see Step 1, page 12).

Remember, you only need to go through the procedures below for those step/activities that have been identified as containing a potential training requirement.

To identify the knowledge (only knowledge, not skills) associated with the step/activity, all you need to do is ask yourself the following question:

> What does a person need to know in order to perform the step/activity?

To prompt an answer to this question, follow the suggestions below:

A. Ask yourself--Does the student need to be able to recall the meaning of any terms, jargon, or codes? If "Yes," which terms, jargon, or codes?

B. Read the step/activity carefully and identify the objects (components or parts) that are involved. For each object ask yourself the following questions:

   1. Does the student need to be able to locate the object or component?

   2. Does the student need to be able to name the object or component? That is, is the student required to associate a label with the object?

   3. Does the student need to be able to describe the object or component?

C. Read the step/activity carefully and decide if the step/activity implies an ordering of objects, events, or signals. For example, do cables have to be connected in a specific order, or do bolts or fasteners have to be tightened in a specific order?

D. Ask yourself--Does the student have to recall a principle or fact to perform the step/activity? For example, does

1. TASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES		

9. REQ	10. REF	11. BEHAVIORAL REQUIREMENT	12. SKILLS/KNOWLEDGE TRAINING REQUIREMENT						13. TAX CODE	14. TRAINING DEVICE REQUIRED							15. ALT MEDIA	16. METHOD	17. COMMENTS
			a. New	b. Condition	c. Criteria	d. Negative Transfer	e. Tool/Equip	f. None		a. Difficult	b. Condition	c. Criteria	d. Hardware Cues	e. Tool/Equip	f. Hi Conseq	g. Time/Freq			

Form 2

Figure 7. FORM 2

he have to recall Ohm's law or state a relationship between parts or components?

E. Ask yourself--Does the student have to discriminate between objects, signals, or events? For example, does he have to make discriminations between patterns on a screen which have a similar appearance? Does he have to discriminate between objects with a high degree of resemblance?

F. Ask yourself--Does the student have to classify objects, events, or signals? For example, does he have to be able to tell which class a signal belongs to?

G. Ask yourself--Does the student have to use any rules to complete the step/activity? For example, does he have to recall that if situation X, then do Y?

H. Ask yourself--Does the student have to make a decision? If yes, what criteria does he use in making the decision?

You should be very careful when responding to the questions. For example, being able to locate an object is different from being able to name the object. In location all the student needs to do is locate or find the object--he does not need to locate it and then associate a name with the object. The difference, although small, influences the type of training that you design--getting students to name is more difficult than getting them to locate. To help you answer the questions you should review the skills and knowledge taxonomy in Table 2 (page 22). Read the description of each taxonomic element. The description should help you to answer the above questions as well as clarify the differences between the taxonomic elements.

As you answer each question be sure you list the identified knowledge in Column 11 of FORM 2. You should phrase the knowledge statement very carefully. If possible, you should list any information that might help you in forming an objective. Although a knowledge statement is not an objective, you should try to make it as close as possible to an objective. If you know of certain performance conditions or criteria they should be specified in the statement.

The importance of this substep cannot be overstated. You must be positive that you have described precisely and accurately the knowledge the student needs to possess.

In our example "Install CDU" we are at the point where a FORM 2 must be prepared. The prepared FORM 2 is in Figure 8 (page 32). It should be recalled that the only step/activity that contained a potential training requirement was Step/Activity 3, "Connect aircraft

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XXXX 01	INSTALL CDU	RJH	09 15 80	1 1

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	XXXX	T.O. 452520 PAGE 402

9. REQ	10 REF	11. BEHAVIORAL REQUIREMENT	12. SKILLS/KNOWLEDGE TRAINING REQUIREMENT						13 TAX CODE	14. TRAINING DEVICE REQUIRED							15 ALT MEDIA	16 METHOD	17 COMMENTS
			a. New	b. Condition	c. Criteria	d. Negative Transfer	e. Tool/Equip	f. None		a. Difficult	b. Condition	c. Criteria	d. Hardware Cues	e. Tool/Equip	f. Hi Conseq	g. Time/Freq			
1	-3	Locate wiring connector 32A.																	
2	-3	Locate CDU connector J1.																	
3	-3	Recall order of connection (attach 32A first.)																	
4	-3	Connect and secure cable with connector by rotating locking ring counter clockwise.																	
5	-3	Identify the proper set of steps/activities in the TO associated with installing the CDU.																	

Form 2

wiring connector 32A to CDU connector J1, then secure by rotating counterclockwise. Note: this cable must be connected first." To identify the knowledge associated with the step/activity we asked, "What does a person need to know in order to perform the step/activity?" Then we followed the procedure provided above. The procedure indicated that the student had to: "locate wiring connector 32A," and "locate connector J1 on the CDU." These potential requirements were recorded on the FORM 2, Column 11. Next the procedure indicated that the student had to recall an ordering--he had to recall that connector 32A was attached first. This knowledge was also recorded on the FORM 2.

Having identified the knowledge for the step/activity, the next operation is to identify the skills associated with the step/activity.

To identify the skills all you need to do is ask yourself the following question:

What manipulations or movements are required to successfully complete the step/activity?

To answer this question follow the procedure below:

A. Examine the "verbs" in the step/activity statement. The verbs usually indicate physical movement.

B. Ask yourself--Does the step/activity involve:

1. Coordination between limbs?

2. Quick movements to stimuli or inputs?

3. Special strengths, endurance, or balance?

In our example, the only skills are: "Connect cable and secure cable with connector by rotating locking ring counterclockwise." These skills are also recorded on FORM 2, Figure 8 (page 32).

You now have identified the skills and knowledge associated with the steps/activities. Your next task is to identify the skills and knowledge associated with the total task. To identify the knowledge ask yourself:

Considering the task as a whole, is there any additional knowledge not reflected in each step/activity?

To answer this question ask yourself the following questions:

A. Does the student have to recall the steps/activities in their proper order? If "Yes," you will need to write a knowledge indicating this. If a clearly written TO exists, then the student will not have to recall any of the steps/activities from memory. If "Integration only" is checked, then a knowledge statement needs to be prepared for this integration.

B. Are there any concepts or principles that must be known to perform all the steps/activities? If "Yes," what are they? For example, the student might need to know the results of the task's impact upon other tasks, or have to know when this task is performed in relation to other tasks.

C. Is there any special relationship between the steps/activities within the task? For example, is step/activity X dependent upon step/activity Y?

In our example, "Install CDU," the only total task knowledge is--"Identify the steps/activities in the TO involved in installing the CDU." The knowledge was not written as a recall because the TO for this task is clear; the performer doesn't need to recall the steps/activities, since they are provided in the TO. This knowledge has also been recorded on the prepared FORM 2 (Figure 8, page 32).

Your last operation in identifying skills and knowledge is to identify any skills associated with the task as a whole. To identify these skills ask yourself:

Does the task, as a whole, require any movement or manipulation related to all the steps/activities?

To answer the question, follow the procedure below:

A. Determine if the task, as a whole, must be performed in an awkward position. For example, if the task, as a whole, must be performed in cramped quarters, you should write a skill statement such as--"Perform steps/activities to install CDU in restricted quarters."

B. Ask yourself--Does the task, as a whole, contain any special conditions requiring balance, strength, and/or coordination?

C. If the task is "new" (indicated by a check Column 11a of FORM 1), then write a statement indicating the task, as a whole, must be performed by the student.

In our example, "Install CDU," there are no whole task skills that need to be considered. The task is not performed in cramped quarters and no balance, strength, or coordination activities exist. In addition, the task is not new.

You have now completed Substep 3; that is, you have identified all the skills and knowledge associated with the task as a whole, and you have identified all the skills and knowledge associated with each step/activity. You should have written a skill and/or knowledge statement to account for each check in Column 11 of FORM 1. If there is not such a correspondence, then you have missed something and you should carefully review your FORM 2.

Substep 4. Select the Skills and Knowledge to be Taught

Now that you have identified all the skills and knowledge associated with the task, you are ready to decide which skills and knowledge should be included in your training program. It is possible that some of the skills and knowledge you have identified are already known by the target population. Thus your task is to identify which skills and knowledge need to be included and which skills and knowledge can be eliminated from your training program. It is in this substep that you determine the training requirements.

To decide which skills and knowledge should be taught follow the procedures in Figure 9 (page 36). This flow chart asks you specific questions about each skill and knowledge. A "Yes" answer to any of the questions indicates that the particular skill or knowledge must be included in your training program. A "No" answer to all the questions indicates that the skill or knowledge can be eliminated from further consideration.

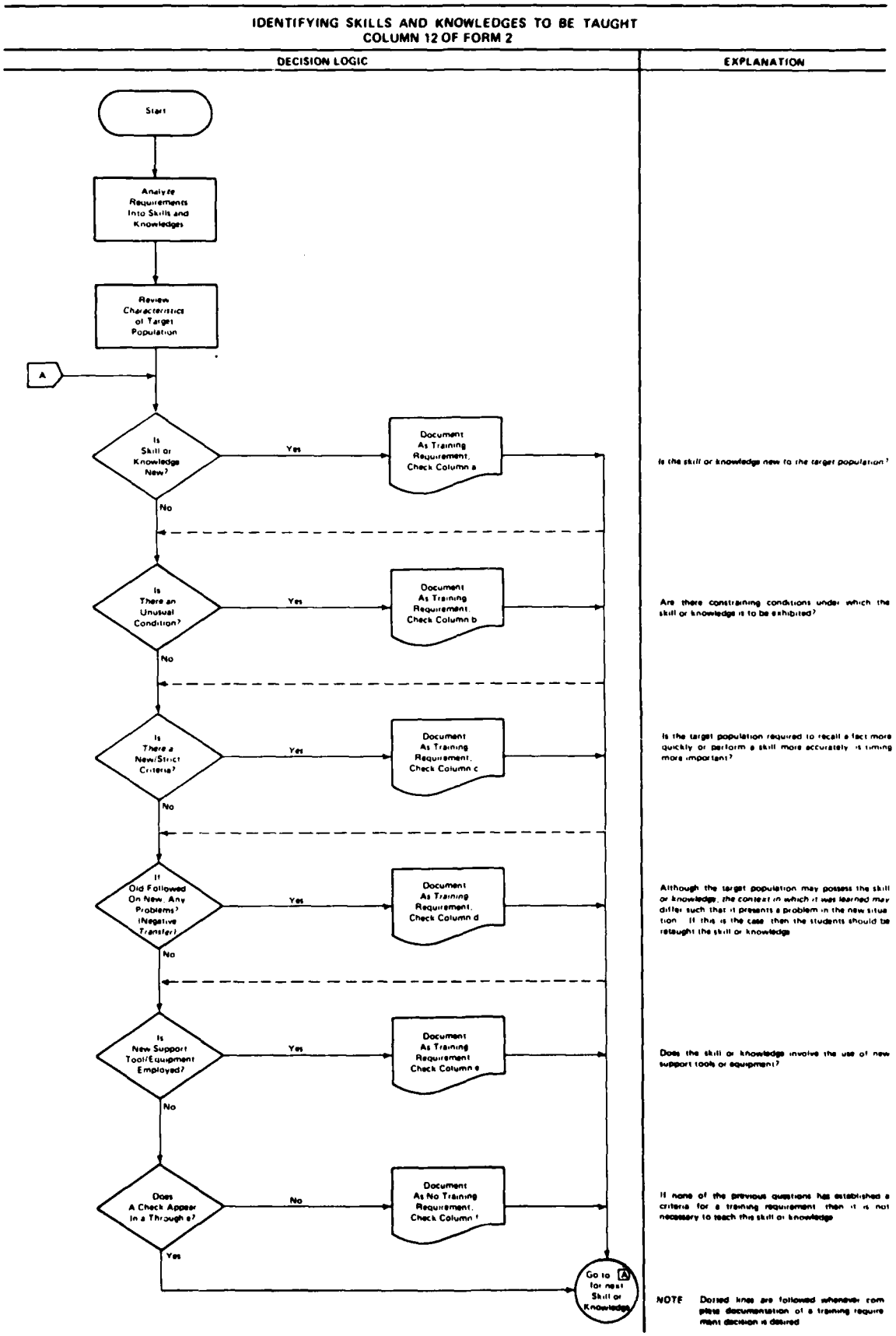


Figure 9. Identifying Skills and Knowledge to be Taught, Column 12 of FORM 2

The questions asked are:

A. Is the skill/knowledge new to the students? A "Yes" indicates that the skill or knowledge must be included in your training program. A "No" answer directs you to the next question.

B. Is there an unusual condition attached to the skill or knowledge? If the skill or knowledge is not new then it may have an unusual condition requiring inclusion of the skill or knowledge in your program.

C. Is there a new criterion of performance? Even though the skill or knowledge is not new it may contain a more restrictive criterion than the student has mastered in the past. For example, "Recall the steps/activities to install CDU in two (2) minutes rather than five (5) minutes."

D. Is there the possibility of negative transfer? The skill or knowledge may require the student relearn a previously learned fact. For example, "Attach cable A before cable B."

E. Does the skill or knowledge require the use of a new tool or support equipment? If "Yes" then the skill or knowledge must be included in your training.

Document your answers to the questions in the appropriate spaces on FORM 2 (Column 12). If there are no checks in a given row (for a particular skill or knowledge), then no training requirement exists. If this is the case, place a check in the "No Training Requirement" column.

Let's illustrate the use of the flow chart by continuing our example. The completed FORM 2 is in Figure 10 (page 38). The first two entries "Locate connector 32A" and "Locate connector J1" were determined to be new to the student. The next knowledge, "recall order of the connections" was also determined to be new. In addition, it also contained an instance of potential negative transfer. Thus, the appropriate column on FORM 2 was checked. The next item, a skill, "attach and secure connector" was determined not to be new or involve unusual conditions, unusual criteria, chances for negative transfer, or new tools or equipment. Since no column was checked, the skill was determined not to be a training requirement, and the "None" (no training requirement) column was checked. The last knowledge, a whole task knowledge, "Identify CDU installation steps/activities in TO,"

1 (TASK) SUBTASK NUMBER	2 (TASK) SUBTASK TITLE	3 INITIALS	4 DATE	5 PAGE OF
XXXX01	INSTALL CDU	RJH	09-15-80	1 OF 1

6 WUC	7 AFSC	8 ADDITIONAL INFORMATION SOURCES AND DATES
XXX	XXXX	TO 452520, PAGE 402

9 REQ	10 REF	11 BEHAVIORAL REQUIREMENT	12 SKILLS KNOWLEDGE TRAINING REQUIREMENT						13 TAX CODE	14 TRAINING DEVICE REQUIRED							15 ALT MEDIA	16 METHOD	17 COMMENTS
			a. New	b. Condition	c. Criteria	d. Negative Transfer	e. Tool/Equip	f. None		a. Difficult	b. Condition	c. Criteria	d. Hardware Cues	e. Tool/Equip	f. Hi Conseq	g. Time Freq			
1	3	Locate wiring connector 32A.	✓						ASO										
2	3	Locate CDU connector J1.	✓						ASO										
3	3	Recall order of connection (attach 32A first).	✓			✓			RPR										
4	3	Connect and secure cable with connector by rotating Locking ring counter-clockwise.						✓											
5	3	Identify the proper set of steps/activities in the TO associated with installing the CDU.	✓						ASO										

Form 2

FIGURE 10. FORM 2, SKILL/Knowledge Training Requirements

was determined to be new and thus was identified as a training requirement.

When a skill or knowledge has been identified as a training requirement, it is then classified according to the taxonomy on page 22. Table 2 presents the taxonomic groupings, their associated three-letter codes and sample verb lists. Examples and descriptions of each category are given as well. For the present example, the verb lists were used to determine how to classify each skill or knowledge requirement, then the appropriate taxonomic codes were entered under Column 13 on FORM 2 (Figure 10, page 38).

As you become familiar with the flow chart used to determine training requirements, you might find it reasonable to combine this substep with the previous substep. That is, you might find it appropriate to list on the FORM 2 only those skills and knowledge which meet the criteria specified in the flow chart; i.e., to list only the skills and knowledge which would be training requirements.

Special Directions for Troubleshooting Tasks

Tasks involving troubleshooting require special consideration. The approach used for analyzing and documenting these tasks differs from the general approach described in other sections of Step 3. Troubleshooting tasks may involve many steps, with the order and inclusion of the steps directly dependent upon the outcome of previous steps. Usually the troubleshooting task is represented as a whole in a logic tree, which depicts the branching of steps contingent on various outcomes or decisions. Decision tree documentation is discussed in AFP 50-58 (Volume II, Chapter 2, pages 2-23 to 2-27). In analyzing troubleshooting tasks, a logic tree should always be appended to FORM 1. If such a tree does not already exist, then you should construct one, following the procedures in AFP 50-58.

When you have identified a troubleshooting task as a job requirement, the analysis of the task into steps/activities can become rather complex. Isolating a malfunction is usually accomplished using the split-half technique. Essentially, questions are asked or tests are performed which eliminate half of the available alternatives. Successive tests and questions continue to subdivide the population of components which may be responsible for the malfunction. This process can be difficult to document.

A lengthy list of steps and activities may be generated if you were to represent all the branches of a task's troubleshooting logic

tree in your task analysis. Instead, you may want to select a subset of the possible malfunctions and list only those steps or activities related to identifying this subset, unless, of course, the system diagnosis is performed by computer-driven test equipment. In such a case, all possible malfunctions should be included and the student should be instructed in the operation of the equipment.

Identify Malfunctions

When selecting a subset of malfunctions you should chose a representative sample. Some considerations to guide you choice are listed here. You should select malfunctions which:

1. Occur frequently.
2. Are difficult to detect.
3. Have the stringent time and error requirements associated with their isolation.
4. Include a representative group of system parts and components.
5. Cover all of the main decision points in the logic tree.

Data should be available from the manufacturer or test personnel regarding the most probable malfunctions. Hopefully the list of steps/activities that is generated following these guidelines will limit the redundancy appearing in Column 10 of FORM 1.

Identify Steps/Activities

To identify the steps/activities of the task for the sample of malfunctions you have selected, use the guidelines in Substep 1 on page 21.

Once the steps/activities of the malfunction task have been identified, screen them for training requirements using the flow chart on Figure 5 (page 25). Document your decision in Column 11 of FORM 1.

Identify Skills/Knowledge

The next step in the analysis procedure is to identify the skills and knowledge required for successfully performing the steps/activities classified as training requirements. There are now two options

open to you. You must decide if you wish to train students only in the procedural location and/or identification of specific malfunctions or if you prefer to teach system theory as an adjunct to fault isolation. This decision will directly determine the types of skills and knowledge that you later identify, and will bear a strong influence on the type of training that you develop.

Teaching troubleshooting theory will require the students to learn basic system/subsystem principles of operation, as well as gain a knowledge of system components, to guide the choice of a strategy for fault isolation. In contrast, teaching students the procedures to locate the source of a malfunction necessitates little training in system theory, as a well-written TO can provide most of the information needed to perform the troubleshooting task.

If you chose to teach troubleshooting only as malfunction identification and isolation (merely an execution of the TO), then the identification of skills and knowledge will be different from that required for learning troubleshooting from a system theory perspective. The need to recall facts or principles will seldom appear in your list. In fact, the skill and knowledge list may be quite short, if the TO is well written.

Ask yourself the following questions to identify the knowledge required to perform each step/activity:

A. Is the TO clearly written? If not, specify as a knowledge requirement any additional information you feel the student needs to make decisions. This includes knowing what to do and in what sequence, knowing what to look for, and being able to recognize a sign of a malfunction.

B. Does the student have to locate/identify any components, parts, or equipment? Does the student have to interpret a schematic or wiring diagram?

C. Does the student have to discriminate between objects, signals, or events? Is a judgment required to determine if a given reading is within tolerance limits? Are fine discriminations required when inspecting components?

D. Does the student have to use a rule to complete the step/activity?

Several steps may rely on the same underlying knowledge, and this knowledge need only be listed once in Column 11 of FORM 2. Be sure to reference all of the steps or activities requiring this knowledge.

To identify the skills associated with the troubleshooting procedures, examine the verbs in the step/activity statement and ask yourself the following questions:

A. What skills are required to set up test equipment; (i.e., connect, calibrate, adjust, select the function and range, prime equipment controls) to obtain accurate and reliable readings?

B. What tool skills are needed to gain access to test points?

C. Are there any coordination, timing, strength, or balance skills required?

Now ask youself the questions appearing on pages 34 and 35 to prompt the identification of skills and knowledge associated with the task as a whole. Once you have done this, you will have identified all the skills and knowledge involved in following the troubleshooting procedure documented in the TO.

If you opt to teach troubleshooting from a system theory perspective you will have to identify additional knowledge requirements related to facts and principles underlying the operation of the system. To identify these knowledge requirements, consider the following:

A. Think of the functions of the system components involved in this task. Will a factual knowledge of which components are responsible for what functions aid the student in performing the troubleshooting activities? Where this is the case, document the requirements in Column 11 of FORM 2.

B. A basic concept of logical troubleshooting is that the proper operation of a system component depends upon proper inputs from other systems or other components within the same system. What knowledge should the student have about system element interrelationships? Which input/output relationships should the student know? (Do you want the student to know whether system components are wired in series or parallel?)

C. Does the student need to know the capabilities or limitations of test equipment (set-up time, common errors, precision limitation)?

D. Does the student need to apply a knowledge of system flow to find components "upstream" or "downstream" of a given component, and use test results to identify additional "good" or "bad" components?

E. What rules or principles guide component operation in the system task being analyzed (such as Ohm's law)?

When you are certain that you have identified all the skills and knowledge for either approach to teaching troubleshooting, then screen the list for training requirements. Use the procedure outlined in Substep 4 (page 35).

Example

An example of troubleshooting step/activity and skill/knowledge identification has been prepared. The example involves the exhaust nozzle of a jet engine system. Two troubleshooting tasks were taken from the decision tree: "Troubleshoot Exhaust Nozzle Actuator" and "Troubleshoot Exhaust Nozzle Indicator." These were selected based on the frequency of malfunctions in the actuator and indicator components. Steps and activities for these two tasks appear on the FORMs 1 in Figures 11 and 12, pages 44 to 49. Training requirements were determined by using the flow chart provided in Figure 5 (page 25).

The decision was made to identify skills and knowledge associated with the isolation of malfunctions in these specific components only; system theory will not be taught. The skills/knowledge are identified on the FORMs 2 in Figures 13 and 14 (pages 50 to 52). Training requirements were determined by using the procedure described in Substep 4 (see Figure 9, page 36). Taxonomic codes are listed for skills and knowledge determined to be training requirements.

Concluding Remarks

This step, (Determine Training Requirements), is complicated and involved. If you have not stated the skills and knowledge correctly or if you have not identified all the skills and knowledge, then your training program will be inappropriate or incomplete. Your students will leave the course ill-prepared to do the job.

Although the procedures above help you to determine training requirements, the procedures are not completely devoid of analytical judgments. Many of the decisions made in this step are dependent upon your expertise, your knowledge of the maintenance requirements, your knowledge of the target population, and your knowledge of how people learn.

1. (TASK) SUBTASK NUMBER	2. (TASK) SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XX-TS01	TROUBLE SHOOT EXHAUST NOZZLE ACTUATOR	JAS	2-15-80	1 5

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	
1	Visually inspect actuator assembly. If there are visible signs of damage, then unit must be replaced. Refer to task EN-R14.			✓			✓	
2	Retract actuator rod.						✓	
3	Loosen locknut A-7 on A-8 cable locking bolt A-9.						✓	
4	Turn A-8 cable clockwise until cable unscrews from sheave steel (A-1); remove cable.						✓	
5	Measure length of A-8 cable, if cable is not between 89.03 and 89.38 inches, then it must be replaced. Refer to task CA-16.			✓				
6	Carefully coil up A-8 cable and lay aside.						✓	
7	Withdraw female end of telescope unit (A-6) from cable A-14.	✓						
8	Install female end of telescope unit (A-6) onto male unit (A-3). Slide parts together until female section touches joint.	✓						

Form 1

Figure 11. FORM 1 Example, Task XX-TS01

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XX-TS01	TROUBLE SHOOT EXHAUST NOZZLE ACTUATOR	JAS	2-15-80	2 3

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	
9	Slide parts back and forth several times and observe any binding. If telescopic unit does not slide freely, then it must be replaced. Refer to "RMV/RPL Feedback Telescopic Unit," Task EN-R12.			✓				
10	Manually rotate splined hub (C-2) and observe. If hub does not turn freely, then AB fuel control must be replaced. Refer to task EN-R13.			✓				
11	Loosen and remove bolt B-2.						✓	
12	Unscrew rod ends (B-1 and B-7) from Barrel.						✓	
13	Insert a piece of lock wire into inspection hole B-9. If lockwire fails to pass through link, then shaft assembly must be replaced. Refer to task EN-S20.						✓	

Form 1

Figure 11. FORM 1 Example, Task XX-TS01 (Continued)

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XX-TS01	TROUBLE SHOOT EXHAUST NOZZLE ACTUATOR	JAS	2-15-80	3 3

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	
14	Remove cotter pin (D-14).						✓	
15	Loosen and remove nut D-15 and washer D-14.						✓	caution: Do not lose Pivot pin (D-20) or spacer (D-13).
16	Connect 1/4 inch extension with drive bar D-12.					✓		
17	Use torque wrench to rotate bar counter clockwise.					✓		
18	Measure torque. If torque is less than 5 LB./IN., then shaft must be replaced. Refer to task EN-59			✓		✓		
19	Re install actuator assembly. Problem is not variable exhaust nozzle actuator.						✓	

Form 1

Figure 11. FORM 1 Example, Task XX-TS01 (Continued)

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XX-TS02	TROUBLE SHOOT NOZZLE POSITION INDICATOR.	JAS	2-15-80	1 3

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	
1	Connect part number 21C58 6 of M37 test unit to nozzle position indicator.					✓		
2	Rig console for engine running, refer to "Engine test stand installation manual" for procedure.						✓	
3	Start engine. Refer to "Maintenance support information manual" for procedure. IF abnormal conditions occur, shut down engine immediately according to emergency procedure.						✓	Caution: test stand must be securely anchored before attempting to run engine. Assume student can identify abnormal conditions and knows emerg. procedure.
4	Air motor engine until tachometer indicates 14 percent RPM.						✓	

Form 1

Figure 12. FORM 1 Example, Task XX-TS02

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XX-TS02	TROUBLE SHOOT NOZZLE POSITION INDICATOR	JAS	2-15-80	2 3

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	
5	Advance power control lever to "idle" position and observe test set reading. If test indicator does not measure 78-91 percent nozzle, then indicator must be replaced. Refer to task EN-R03.			✓		✓		
6	Press "start button". If light off does not occur within 5 seconds, then indicator must be replaced. Refer to task EN-R03.						✓	
7	Slowly advance power control level to 50°. If nozzle position indicator reading does not decrease, or shows "stepping" of more than 3°, then indicator must be replaced. Refer to task EN-R03			✓				

Form 1

Figure 12. FORM I Example, Task XX-TS02 (Continued)

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XX-TS02	TROUBLE SHOOT NOZZLE POSITION INDICATOR	JAS	2-15-80	3 3

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9. ACT NO.	10. STEP/ACTIVITY IDENTIFICATION	11. STEP/ACTIVITY TRAINING REQUIREMENT						12. COMMENTS
		a. New	b. Condition	c. Criteria	d. Neg. Transfer	e. Tool/ Equip.	f. Integ. Only	
8	Slowly retard power control lever while observing nozzle position indicator on test set.						✓	
9	Observe throttle angle when reading stabilizes. If throttle angle is not 43 ± ½ degrees, then indicator must be replaced. Refer to task EN-R03.			✓				
10	Disconnect test set. Problem is not in this system.						✓	

Form 1

Figure 12. FORM 1 Example, Task XX-TS02 (Continued)

1 TASK/SUBTASK NUMBER	2 TASK/SUBTASK TITLE	3 INITIALS	4 DATE	5 PAGE OF
XX-T501	TROUBLE SHOOT EXHAUST NOZZLE ACTUATOR	JAS	9-16-80	1 2

6 WUC	7 AFSC	8 ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9 REQ	10 REF	11 BEHAVIORAL REQUIREMENT	12 SKILLS/KNOWLEDGE TRAINING REQUIREMENT						13 TAX CODE	14 TRAINING DEVICE REQUIRED							15. ALT MEDIA	16 METHOD	17 COMMENTS
			a New	b Condition	c Criteria	d Negative Transfer	e Tool/Equip	f None		a Difficult	b Condition	c Criteria	d Hardware Cues	e Tool/Equip	f Hi Conseq	g Time/Freq			
1	-1	Detect visible damage to actuator.			✓				DIS										
					✓				RUS										
2	-1	Apply replacement rule.						✓											
3	-5	Identify A-8 cable.																	
4	-5	Measure cable length accurately to nearest .01 inch.			✓				RMV										
5	-5	Apply acceptable length range and replacement rule						✓											
6	-7, -8	Locate female end of telescopic unit (A-6)	✓						ASO										
7	-7	Locate cable A-14	✓						ASO										
8	-7	Disconnect female end of telescopic unit (A-6).						✓											
9	-8	Locate male end of telescopic unit (A-3).	✓						ASO										
10	-8	Insert male plug into female telescopic unit.						✓											
11	-8	Position female unit at joint.			✓				PSM										
12	-9	Slide male and female units.						✓											
13	-9	Detect binding.			✓				DIS										
14	-9	Apply replacement rule.						✓											
15	-10	Locate splined hub.						✓											
16	-10	Rotate splined hub.						✓											

Form 2

FIGURE 7-1. FORM 2, Troubleshooting Example Task XX-T501

1. TASK/SUBTASK NUMBER	2. TASK/SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE OF
XX - TS01	TROUBLG SHOOT EXHAUST NOZZLE ACTUATOR	JAS	9-16-80	2 2

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9. REQ.	10. REF.	11. BEHAVIORAL REQUIREMENT	12. SKILLS/KNOWLEDGE TRAINING REQUIREMENT						13. TAX CODE	14. TRAINING DEVICE REQUIRED							15. ALT MEDIA	16. METHOD	17. COMMENTS
			a. New	b. Condition	c. Criteria	d. Negative Transfer	e. Tool/Equip	f. None		a. Difficult	b. Condition	c. Criteria	d. Hardware Cues	e. Tool/Equip	f. Hi Conseq	g. Time/Freq			
17	-10	Discriminate uneven rotation or binding			✓				DIS										
18	-10	Apply replacement rule.						✓											
19	-16	Locate drive bar D-12						✓											
20	-16, 17	Engage torque wrench to drive bar.					✓		RMV										
21	-18	Measure torque accurately to nearest ft./LB.			✓		✓		RMV										
22	-18	Apply torque range criteria and replacement rule.						✓											

Form 2

Figure 13. FORM 2, Troubleshooting Example Task XX-TS01 (Continued)

1. TASK/SUBTASK NUMBER	2 TASK/SUBTASK TITLE	3. INITIALS	4 DATE	5 PAGE	OF
XX-TSO2	TROUBLE SHOOT NOZZLE POSITION INDICATOR	JAS	9-16-80	1	1

6. WUC	7 AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	3A1C	T.O. 9954 EN 1-11-80

9. REQ	10 REF	11. BEHAVIORAL REQUIREMENT	12. SKILLS/KNOWLEDGE TRAINING REQUIREMENT						13. TAX CODE	14. TRAINING DEVICE REQUIRED							15 ALT MEDIA	16 METHOD	17 COMMENTS
			a. New	b. Condition	c. Criteria	d. Negative Transfer	e. Tool/Equip	f. None		a. Difficult	b. Condition	c. Criteria	d. Hardware Cues	e. Tool/Equip	f. Hi Conseq	g. Time/Freq			
1	-1	Locate nozzle position indicator.						✓											
2	-1	Locate part 21C58G of M37 test unit.					✓		ASD										
3	-1	Clip test unit part 21C58G to indicator.						✓											
4	-5	Locate power control lever.						✓											
5	-5, 7, 9	Locate test set indicator.					✓		ASO										
6	-5, 7, 9	Read test set indicator.						✓											
7	-5, 7, 9	Apply acceptable criteria and replacement rule.			✓				RUS										Although Criteria are given in TO, student must interpret
8	-7	Discriminate between "Stepping" of more than 3° and less than 3°.			✓				DIS										

Form 2

Figure 14. FORM 2, Troubleshooting Example Task XX-TSO2

☐ STEP 1 Identify System Maintenance Requirements

☐ STEP 2 Identify Characteristics of the Target Population

☐ STEP 3 Determine Training Requirements

■ STEP 4 Determine the Type of Technical Training Materials Required

☐ STEP 5 Sequence Skills and Knowledge (Utilization Plan)

☐ STEP 6 Identify Fidelity and Simulated Features

☐ STEP 7 Select Instructional Features

☐ STEP 8 Prepare ISD Specification

☐ STEP 9 Identify Method

☐ STEP 10 Prepare Course Control Documents (CCD'S)

☐ STEP 11 Prepare Instructional Materials and Tests

☐ STEP 12 Validate Instruction

☐ STEP 13/14 Conduct Training and Evaluate Training

STEP 4. DETERMINING THE TYPE OF TECHNICAL TRAINING MATERIALS REQUIRED

Now that you have identified the skills and knowledge to be included in your training program, you must decide how these skills and knowledge can best be acquired by the students. Some skills and knowledge may need to be practiced on hardware, while other skills and knowledge can be acquired through the use of visual aids, printed materials, or computer assisted instruction.

In this step a procedure is presented for identifying those skills and knowledge that must be taught using some sort of hardware (such as a simulator, a mockup, or actual equipment). This is a major decision, which greatly influences your training program. The procedure presented is an initial separation of the training requirements into two groups. As you progress through later steps, the media designated for teaching a particular skill or knowledge may change.

This decision is made in the 3306th Procedural Handbook (Chapter 2, pages 53 to 56) by asking a set of questions. The leading question asks whether *hands-on practice on hardware* is required. The approach suggested below helps you to answer this question by asking a set of related questions. The answers to the questions determine if hands-on practice is required for training a given skill or knowledge.

Also in this step you will make a media selection for those skills and knowledge that do not require hardware. This initial selection should be considered only tentative. As you progress through the rest of the steps in the procedures, the media class selected for a given skill or knowledge may change.

The substeps involved in this step are:

Substep 1. Identifying Skills and Knowledge Requiring Practice on Hardware

Substep 2. Select Media for the Remaining Skills and Knowledge

These two substeps are discussed in greater detail below.

Substep 1. Identify Skills and Knowledge Requiring Practice on Hardware

Once the training requirement has been identified, it becomes necessary for you to determine whether or not practice on hardware is required. Essentially, you must ask yourself questions regarding the difficulty of skill and knowledge acquisition and execution, the importance of hardware cues for performance, and the criteria and conditions of performance.

The entire practice decision process has been outlined in a flow chart format (see Figure 15, page 56). The right-hand side of the flow chart provides an explanation of how each decision is made, and contains of a series of subquestions. A "Yes" answer to any subquestion indicates a "Yes" answer to the major question being asked. Each decision corresponds to a column under Item 14 on FORM 2. Following the dashed lines in the flow chart will provide a complete documentation of the decision process; it will force you to ask every question in the flow chart.

The following considerations are used to guide you in identifying skills and knowledge requiring practice on hardware:

A. Is the skill or knowledge difficult to execute? If it is difficult to execute it is undoubtedly also difficult to acquire without some type of hands-on practice. Skills that involve precise adjustment or complex actions (for example, lengthy procedures) are good examples of training requirements requiring practice on hardware devices.

B. Is the display of the skill or knowledge required under unusual circumstances, such as a noisy or limited access environment? If so, these conditions warrant practice of the skill or knowledge on hardware of some type where the environment approximates the real job environment.

C. Are the timing or the error criteria so strict as to require experience performing that task on equipment? That is, stringent criteria may be difficult to achieve unless practice on hardware is provided.

D. Does the operator receive feedback from the equipment? You should consider those instances where visual, tactual, or auditory cues from the hardware are critical. Those skills or knowledge that require feedback from the hardware should be practiced on hardware.

E. Are new/modified support tools or test equipment used to execute the skills or knowledge? If yes, then the student will need to practice using the tools and equipment.

IDENTIFYING SKILLS AND KNOWLEDGES TO BE TAUGHT ON A TRAINING DEVICE
COLUMN 14 OF FORM 2

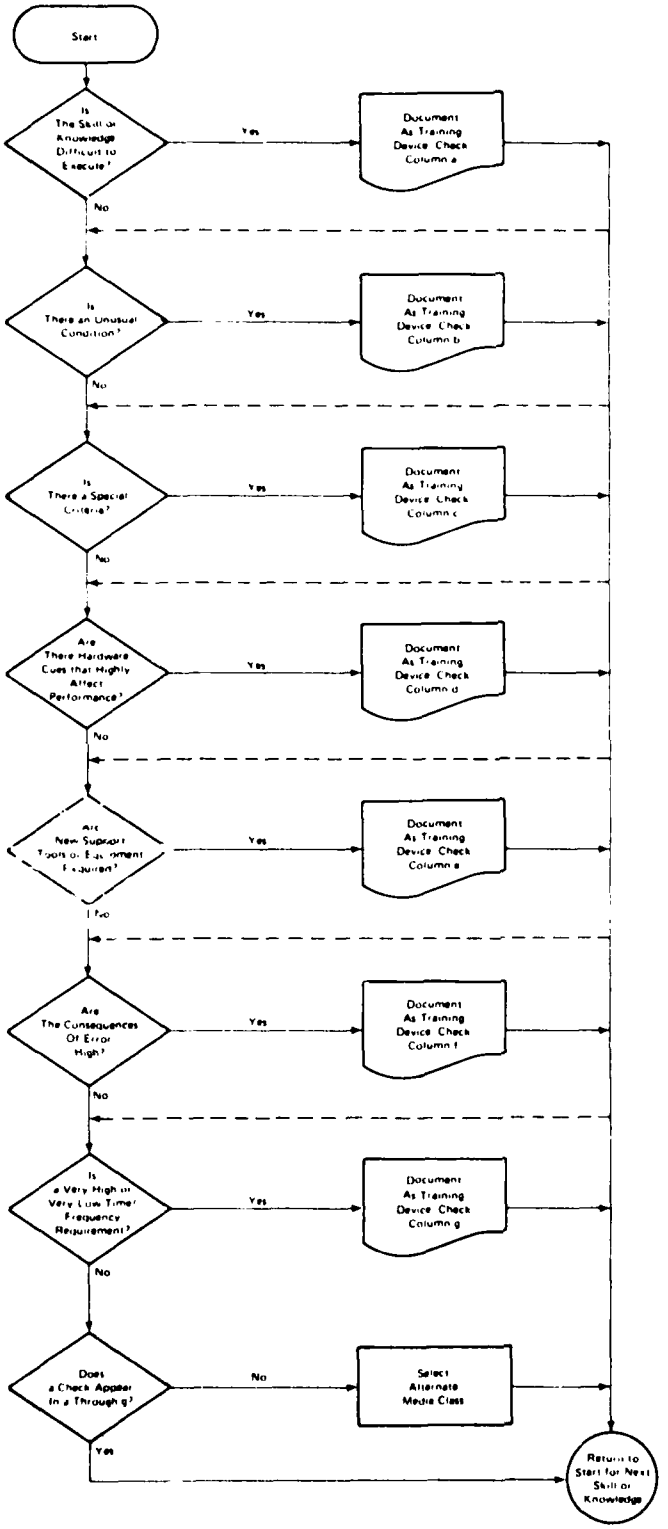
DECISION LOGIC	EXPLANATION
	Are there many similar inputs to analyze? Are there many responses to choose from? Is the action required complex? Is precision or dexterity involved? Is an error likely to occur? Exclude those procedures that are lengthy but which have well documented T.O.'s detailed schematics etc. to serve as job aids. Are there any environmental constraints under which performance must occur? Is timing of actions important? Will personnel be acting in teams such that coordination between members must be practiced? Consider especially those situations in which information is fed rapidly or under noisy stressful conditions where there is little time between signal and response when the operator cannot set the pace in perceiving information or adjusting controls when several controls must be selected and moved at about the same time or when manipulations must be performed in limited access. Are there time or error specifications that cannot be met without practice? Consider the extent to which dynamic cues or cues unique to the hardware aid performance. Are there feedbacks (visual auditory tactile) that substantially influence one's actions or serve as important points of reference? (Such as situations where slow but continuous change must be noticed among quickly changing signals.) Exclude from consideration only slight equipment modifications or hand tools whose use is easily acquired by students. Consider personnel safety and possible damage to equipment. Is the elapsed time spent performing this on the job high enough to warrant practice to improve efficiency? Are the occasions where this skill or knowledge required so infrequent that correct performance is unlikely to occur without actual practice? If no device is required then select an alternate media class. NOTE: Follow dotted lines for complete decision documentation.

Figure 4-5. Identifying Skills and Knowledge to be Taught on a Training Device, Column 14 of FORM 2

F. Are the consequences of inaccurate performance high in terms of personal injury or equipment damage? If yes, then a need for practice on hardware seems indicated. However, high equipment damage probability excludes the use of actual equipment in your training.

G. What is the frequency of task performance? A particular skill or knowledge may be performed so frequently or involve such a large amount of time on the job that substantial practice on hardware will lead to greatly improved efficiency. Additionally, you should consider instances where the actual occasions requiring this performance on the job are so infrequent that some type of practice experience is necessary to insure correct performance at those times (an example is an emergency procedure). Be careful not to include those skills and knowledge requiring only minimal practice of a superficial nature in this category, such as listing steps of a frequently required checkout procedure. Alternate response media may be able to meet such training requirements.

H. A "Yes" to any of the above considerations means training hardware of some type is needed. If none of the above considerations have led to a training hardware decision (all answers were "No") for that skill or knowledge requirement, then follow the procedure outlined in the next substep for selecting an alternate media class.

An example utilizing the procedure in Substep 1 has been provided for you and is documented on a FORM 2 (see Figure 16, page 58). A task ("Remove and replace power assembly") has been analyzed into three skill requirements. Only one of these skills, "Disconnect power cable," is a training requirement. To determine if practice on hardware is needed, the questions in Figure 15, page 56 were asked. The skill is not difficult and does not take place under unusual environmental conditions, so Columns 14a and 14b were left blank. There is, however, a special error criterion associated with performing this skill, so a check was placed in Column 14c. Since the connection is tight, a screwdriver must be used to force the connection apart; and care must be exercised not to damage the power cable in the process. This criterion has been noted by the skill in the "Comments" section (Column 17). A screwdriver is a common support tool, so no check appears under Column e in Item 14 (new tool). However, since the consequences of improperly performing this skill (that is, damaging the cable) is quite high (a possible electrical short), Column 14f was also checked.

Substep 2 would be skipped in this example, since there are no remaining skills and knowledge requirements for which media must be specified.

1 (TASK) SUBTASK NUMBER	2 (TASK) SUBTASK TITLE	3 INITIALS	4 DATE	5 PAGE OF
XXXX 03	REMOVE & REPLACE POWER ASSEMBLY	RJH	10-20-80	1 1

6 WUC	7 AFSC	8 ADDITIONAL INFORMATION SOURCES AND DATES
XXX	XXXX	REPORT FW3401, PAGE 172

9 REQ	10 REF	11 BEHAVIORAL REQUIREMENT	12 SKILLS/KNOWLEDGE TRAINING REQUIREMENT: a. New	b. Condition	c. Criteria	d. Negative Transfer	e. Tool/Equip	f. None	13 TAX CODE	14 TRAINING DEVICE REQUIRED: a. Difficult	b. Condition	c. Criteria	d. Hardware Cost	e. Tool/Equip	f. Hi Conseq.	g. Time/Freq	15 ALT MEDIA	16 METHOD	17 COMMENTS
1	-2	Loosen front panel mounting screws.						✓											
2	-2	Pull front panel out and to one side.						✓											
3	-2	Disconnect power cable			✓				RMV			✓			✓				Force connection apart with screwdriver taking care not to cause cable breakage.

Form 2

Figure 16. FORM 2 Example

Substep 2. Select a Media Class for the Remaining Skills and Knowledge

The above substep separated your skills and knowledge into two groups; those skills and knowledge requiring practice on hardware and those skills and knowledge not requiring practice on hardware. For each skill and knowledge training requirement not requiring practice on hardware you must decide upon the most appropriate media class for presenting the material. The process for selecting the media class is summarized in a flow chart Figure 17, (page 60). The considerations involved are as follows:

A. Decide how familiar the target population is with the material. If the students already have some exposure to the area, Still Visuals, Printed Materials, or Computerized Instruction are appropriate.

B. Where sound is not presented, Moving Visuals or Still Visuals, Printed Materials, and Computerized Instruction can be selected depending on the need to visually display system or operator movements.

C. If sound is appropriate, but depiction of motion is not required, the Audio class is selected. If visuals will enhance an audio presentation, the Sound/Still Visual class is most appropriate.

D. If sound and motion will both provide relevant system information to the student, the Sound/Moving Visual class offers the best.

Enter the three letter media class code shown in Table 3 (page 61) in Column 15 of FORM 2 to document the media class selected.

Keep in mind that these media classes can be used cooperatively to present material in more than one fashion for learning emphasis. Also, consider the relative cost of materials and availability of instructors, facilities, and equipment in making a selection where more than one media class seems appropriate.

Continuing with the example begun earlier in Step 3, "Installing the CDU," it can be seen that none of the skills and knowledge requirements identified for the task need to be practiced on hardware (that is, none of the answers to the questions in Figure 15, page 56, were "Yes"). As such, a different media class has been selected, using the flow chart in Figure 17 (page 60) to teach each of the training requirements listed on the FORM 2. (The completed FORM 2 appears in Figure 18, page 62.) "Locating connector 32A (and J1)" requires only a visual such as a transparency, since no display of motion or sound is necessary.

SELECTION OF MEDIA OTHER THAN HARDWARE

COLUMN 15 OF FORM 2

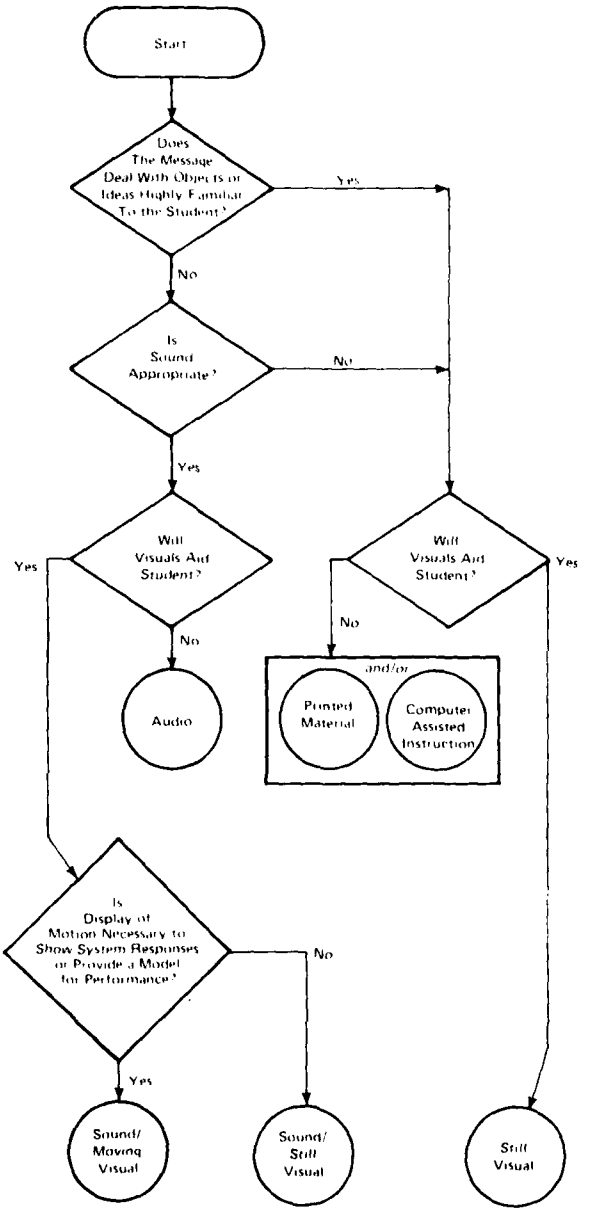
DECISION LOGIC	EXPLANATION
	Will sound provide relevant system stimuli or responses? More difficult material should probably be incorporated in a visual aid. Where visual aspects of an object are not important, written instructions or descriptions may suffice, or tape recorded messages (Audio) may be used. If students have different levels of background and experience, self-pacing through programmed texts or CAI is an alternative. CAI may include audio, visual, or both. Is the working of some mechanical device to be shown? When using visuals, ask yourself whether it is desirable to display exaggerated views (enlargements, color coding, cutaway views of internal mechanisms or parts) of objects.

Figure 17. Selection of Media Other Than Hardware
Column 15 of FORM 2

Table 3
Media Classes

AUDIO	(AUD)	Tape Cassette
PRINT	(PRT)	Graphics* Manual/Job Aids Programmed Text Tech Order
STILL VISUAL	(SVS)	Transparencies Slides Filmstrips
SOUND/STILL VISUAL	(SST)	Sound/Slide Filmstrips
SOUND/MOVING VISUAL	(SMO)	Video Tape Sound Movie Television
COMPUTER ASSISTED INSTUCTION	(CAI)	Terminals
HARDWARE	(HRD)	Models Cutaways Mockups Trainers (Part or Whole Task) Animated Panels Simulators

*Graphics include diagrams, photos, graphs, charts, maps.

1. (TASK) SUBTASK NUMBER	2. (TASK) SUBTASK TITLE	3. INITIALS	4. DATE	5. PAGE	OF
XXXX01	INSTALL CDU	JAS	09-15-80	1	1

6. WUC	7. AFSC	8. ADDITIONAL INFORMATION SOURCES AND DATES
XXX	XXXX	T.O. 452520, PAGE 402

9. REQ.	10. REF.	11. BEHAVIORAL REQUIREMENT	12. SKILLS/KNOWLEDGE TRAINING REQUIREMENT						13. TAX CODE	14. TRAINING DEVICE REQUIRED							15.	16.	17.
			a. New	b. Condition	c. Criteria	d. Negative Transfer	e. Tool/Equip.	f. None		a. Difficult	b. Condition	c. Criteria	d. Hardware Cues	e. Tool/Equip	f. Hi Conseq.	g. Time/Freq	ALT. MEDIA	METHOD	COMMENTS
1	-3	Locate wiring connector 32-A.	✓						ASO								SVS		
2	-3	Locate CDU connector J1.	✓						ASO								SVS		
3	-3	Recall order of connection (attach 32 A first).	✓			✓			RPR								SVS		
4	-3	Connect and secure cable with connector by rotating locking ring counter-clockwise.						✓											
5	-3	Identify the proper set of steps/ activities in the TO associated with installing the CDU.	✓						ASO								PRT		

Form 2

Figure 18. FORM 2 Example

"Recalling the order of connection" can be presented using a series of still visuals (or a moving visual). In this manner, a model for correct performance (attaching 32A first) can be presented. Printed Material was selected for "Identifying the steps/activities involved in installing the CDU." The actual job manual (if av. ble) could serve this instructional purpose.

Having selected a media class, choose a member of that class to use in teaching the skill or knowledge under consideration. A summary of the media classes and their members appears in Table 3 (page 61). Additionally, a listing of the advantages and disadvantages of various media class members appears in Appendix A. These can aid you in making your final media selection by providing information regarding each *medium's* suitability for teaching certain learning objectives, and relative production time/cost estimates. Keep in mind that media selection is still a somewhat subjective process and in many instances there is no single correct selection; media selection often depends upon personal preference. Refer also to the summary of media characteristics provided in AFP 50-58 (Volume IV, Chapter 5, pages 5-8 to 5-36) as an additional aid in making your choice.

You have now identified the materials to be used in training the skill and knowledge requirements.

- ☐ STEP 1 Identify System Maintenance Requirements
- ☐ STEP 2 Identify Characteristics of the Target Population
- ☐ STEP 3 Determine Training Requirements
- ☐ STEP 4 Determine the Type of Technical Training Materials Required
- ■ STEP 5 Sequence Skills and Knowledge (Utilization Plan)
- ☐ STEP 6 Identify Fidelity and Simulated Features
- ☐ STEP 7 Select Instructional Features
- ☐ STEP 8 Prepare ISD Specification
- ☐ STEP 9 Identify Method
- ☐ STEP 10 Prepare Course Control Documents (CCD'S)
- ☐ STEP 11 Prepare Instructional Materials and Tests
- ☐ STEP 12 Validate Instruction
- ☐ STEP 13/14 Conduct Training and Evaluate Training

STEP 5. SEQUENCE SKILLS AND KNOWLEDGE (UTILIZATION PLAN)

At this point in the procedure you have identified the skills and knowledge that need to be included in your training program. In addition, you have identified how those skills and knowledge can best be acquired. That is, you have identified those skills and knowledge that, at this time in the procedure, appear to be candidates to be acquired on some sort of trainer. Furthermore, you have identified those skills and knowledge which can be acquired using other media (e.g., still visuals, printed materials, etc.).

You are now ready to sequence your skills and knowledge. Sequencing the skills and knowledge will help you to detemine how the trainer will be used within the training environment and training situation. How the trainer (some type of hardware) will be used in your training program, influences how the trainer should be designed. Before you can accurately describe the trainer that might be needed in your training program, you must have a rough idea of where in your training program the proposed trainer might be used. A rough idea of this can be obtained by sequencing the skills and knowledge to be included in your training program.

At first glance you might interpret the completion of this step as a request to completely design the entire training program. However, that is not the intent of this step. In both AFP 50-58 and the 3306th Procedural Handbook the design of the whole training program is completed last or at least later in the process. The purpose of this step is to roughly design the training program (roughly sequence the skills and knowledge) and only in enough detail to get an idea about how and when the trainer is to be used. Thinking about the sequence of skills and knowledge will give you some "feel" for the hardware. It is inappropriate to design the hardware or trainer, then sequence your skills and knowledge around the designed hardware.

Starting this step will require you to make an initial assumption. As you continue through the step you should feel free to alter or change this initial assumption. The assumption you want to start out with is . . . you now have a trainer to teach the skills and knowledge identified in Step 4 as requiring some sort of hardware. From this assumption you should begin to think about how the trainer might be used to teach those skills and knowledge. You should start with this assumption unless you have other reasons to assume differently; for example, that you will have two trainers, perhaps one trainer for location or knowledge and another for skill acquisition. As you begin

to sequence the skills and knowledge you should get a feel for how many different kinds of trainers you might need, as well as what those trainers might look like. In addition, as your focus on the trainer or hardware becomes sharper, you will also begin to get a "feel" for how the trainer(s) can be used.

When sequencing the skills and knowledge and thinking about the trainer, you should bring to bear any other information you might have, such as:

A. The training environment (e.g., the classroom size, the possible noise level within the classroom, etc). You should only consider such factors as these if they are known. If they are unknown you may elect to ignore such factors or make some assumptions about them. If you make an assumption about them, you should document the assumption as an assumption. That is, you may ignore any classroom environment consideration, get an idea about how and when the trainer will be used, then consider how the use of the trainer influences or affects the design of the classroom.

B. Maximum class size if known (the size of the class, the number of students, influences the design of the trainer; e.g., if the trainer is intended to be used for demonstration purposes and the maximum number of students who need to "see" the demonstration is large, then the trainer must be designed for a large viewing audience).

C. The number of students who will use the trainer during any practice situation. For example, if in sequencing the skills and knowledge you indicate the trainer is going to be used for students to practice task acquisition, then try to determine how many students will practice at the same time.

You can make as much or as little out of this step as you want to, but it is a critical step in the procedure. You can sequence the skills and knowledge mentally or you can document the desired sequence using the worksheet provided in this section. The output of this step should be:

A. A rough idea of the sequence of skills and knowledge.

B. An initial estimate of how many different kinds of trainers might be needed as well as an idea of how those trainers might look (given any environmental considerations).

C. A rough idea of how the trainer or trainers will be used to acquire the specified skills and knowledge (e.g., as demonstration media and as practice media).

D. The possible reclassification of media selections; e.g., as you sequence skills and knowledge and think about the trainer(s), you might find it necessary or convenient to reclassify skills and knowledge, originally slotted for acquisition using some other media, to acquisition using the trainer (e.g., a "Locate" knowledge might have originally been assigned a slide media, but as you think about the sequence and the trainer, you might decide that the locate behavior can also be acquired on the trainer).

To complete this step the procedure specified below can be followed:

A. Using the grouping of tasks specified in Step 1, and the skills and knowledge identified on the FORMs 2, try to form either one module or as many modules as required; where a module is defined as a block of skills and knowledge (AFP 50-58). Check this initial grouping and see if some of the skills and knowledge are common across groups. If there are common skills and knowledge, consider forming a module of the common skills and knowledge (AFP 50-58, Volume IV, Chapter 2, pages 2-1 to 2-5, offers other strategies).

B. For each module write a terminal objective. That is, indicate or specify what the student is expected to do or learn at the end of the module.

C. Within each module sequence the skills and knowledge; i.e., determine what should be taught first, second, etc. You need not be extremely precise in this initial sequence; you may find it more appealing and practical to identify what is taught first and then last. Your job here is to identify any skills and knowledge prerequisite to other skills and knowledge.

D. Examine the sequence and ask - "If I had a trainer to teach the skills and knowledge identified in Step 4 as requiring some sort of hardware, how would I structure the class?" That is, provide a scenario of how the class would be conducted to reach the specified terminal objective. Again, you need not be extremely precise or think out all the details. Your concern is to get a "feel" for the possible uses of the trainer.

E. Once you have the scenario in mind, ask yourself the following questions:

1. Will one trainer suffice, or would two or more different kinds of trainers be appropriate? For example, you might decide that one trainer for whole task performance is appropriate, while another type of trainer might be appropriate to teach students how to discriminate between different classes of signals.

2. Can and should the trainer (as currently envisioned) be used for demonstration purposes? The answer will be dependent upon how you currently envision the trainer, and the maximum number of students who will view the demonstration (if known).

3. Is there anything in the training environment that inhibits using the trainer as currently envisioned? Will the trainer be noisy? Will the anticipated trainer be too large for the training environment (assuming the training environment is known)? Does the trainer, as currently envisioned, require the classroom to be designed in a certain way or have any special features?

4. Will students use the trainer to practice on? If "Yes," how many students can use the trainer at one time? If "No," then do you really need a trainer? If students are to practice on the trainer, then ask yourself these questions:

   - Are the skills and knowledge sequenced such that prerequisite skills and knowledge are acquired before the practice is actually scheduled?

   - If a student uses the trainer to practice a skill acquisition, then what will the other students be doing while the one or two students practice on the trainer?

5. Can skills and knowledge which are originally assigned to a non-hardware media now be acquired on the trainer as it is currently envisioned? If "Yes," note the skill and knowledge media class change on your FORM 2.

   As you begin to answer the above questions or at least think about them, you should perceive more

sharply what the trainer will look like and how it will be used. This initial perception may change as you progress through the remaining steps, but at least you will now have some idea of how the course will be organized, and particularly how the trainer or hardware will fit into the course. As you can see, this step does not require a great amount of detailed information. The purpose of this step is not a detailed Plan of Instruction (POI), it is only designed to help you think about the trainer and its use.

6. Document the module (the terminal objective, the sequence of skills and knowledge, the scenario, etc.). To document the module you can use the worksheet provided in Figure 19 (page 70). The procedures for completing the worksheet are provided below.

Completion of the Preliminary Sequencing Worksheet

The purpose of the worksheet is to document your initial sequence scenario, and any hardware and environmental implications that resulted from your thinking about the trainer and its place within the training program. You will need one worksheet for each module you have identified. A block by block description of how the worksheet is to be completed is provided below:

Block 1. Enter your initials.

Block 2. Enter the date worksheet is being completed.

Block 3. Enter the module number and/or a descriptive module title.

Block 4. Enter the task numbers which the module discusses. That is, enter by task number (Block 1 of FORM 1) the tasks which are to be part of the module.

Block 5. Write a terminal objective for the whole module. Be sure to specify the behavior clearly and concisely. Also be sure to specify, if at all possible, the conditions under which the criterion behavior is to be displayed, as well as the criteria for successful performance.

PRELIMINARY SEQUENCING WORKSHEET

1. INITIALS	3. MODULE NUMBER AND/OR TITLE
2. DATE	4. TASK NUMBERS

MODULE DESCRIPTION

5. TERMINAL OBJECTIVE
6. SCENARIO
7. SKILL AND KNOWLEDGE SEQUENCE
8. ENVIRONMENTAL IMPLICATIONS
9. HARDWARE IMPLICATIONS

Figure 19. Preliminary Sequencing Worksheet

Block 6. Write a brief scenario of what will happen in the module. Be sure to specify what the student will be doing in the module and briefly describe how the module is structured. You need not go into detail, but you should capture the flavor of the module. The scenario should concentrate on the role of the trainer (how the trainer will be used).

Block 7. Enter the skills and knowledge in their proper sequence (a rough sequence); you need only use the skills and knowledge reference number indicated in your FORMs 2.

Block 8. Enter any environmental implications involving the use of the trainer (e.g., if the classroom environment is known, enter any size limitations; if the environment must be arranged in any special way for the trainer to work in the desired fashion, enter the arrangement; enter any environmental features of the classroom - if known - which would place restrictions on the trainer or its use). For example, if you feel that the trainer is going to be heavy, specify that the trainer might not be useable on the second floor, if the floor loading on the second floor is inadequate.

Block 9. Enter any hardware implications (such as, the trainer will be used for demonstration purposes, or the trainer will be used in a practice situation involving no more than two students, or two trainers will be needed one for this and one for that, etc.).

After completing this step you will be in a position to start designing your hardware. In the next step you will be asked to decide upon the fidelity level of the hardware.

- ☐ STEP 1 Identify System Maintenance Requirements
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- ☐ STEP 12 Validate Instruction
- ☐ STEP 13/14 Conduct Training and Evaluate Training

STEP 6. IDENTIFYING FIDELITY AND SIMULATED FEATURES

At this point in the procedure, you have identified those skills and knowledge that need to be taught with the help of hardware and you have some idea of the hardware that might be used. However, you have not determined the degree of fidelity of this hardware. That is, you have not determined how realistically the hardware must be represented to achieve the specific training requirements. Therefore, the purpose of this step is to determine the degree of fidelity that each component included on your trainer will have.

The fidelity-determination procedures described in this step are a further development of those described on page 74 of the 3306th Procedural Handbook as well as those described in AFP 50-58 (Volume IV). The major addition that the procedure below provides is in the degree of specificity it involves. Prior to this procedure, fidelity decisions were made at the task level; each task was examined to determine if it was exceptionally difficult, complex, or required practice. If the answer to one or more of these questions was "Yes," then a decision was made to teach the task on relatively high-fidelity training hardware; often, this meant simulators. This procedure, as outlined, had two potential weaknesses. The first was that it analyzed the training situation at the task rather than the skill and knowledge level. Often many of the skills and knowledge that make up a task do not need to be taught on high-fidelity equipment even when the other skills and knowledge that are part of the task do. Therefore, if a decision was made to teach an entire task with a high fidelity training device, such a decision would, by implication, cause <u>all</u> of the skills and knowledge to be taught with high fidelity components even though high fidelity was not needed for <u>some</u> of them. What this approach would then produce is an overly-expensive and needlessly capable trainer.

The procedure to be described in this section overcomes the "overkill" problem by taking the hardware analysis procedure one step further than has previously been done, by having you break activities down into skills and knowledge before performing the fidelity analysis. This means that you will be determining the degree of fidelity that will be needed to teach individual skills and knowledge rather than just determining the degree of fidelity that will be needed to teach steps/activities or whole tasks. In this way, only those skills and knowledge that need to be taught on high fidelity training devices

or components will have high fidelity devices or components designed for them, while those skills and knowledge that do not need to be taught on high fidelity devices or components will be taught on lower fidelity training devices or components.

The second problem associated with the previously-developed procedure was that it did not really determine the "important" part of the components that the AFSC works on in performing the maintenance task and/or its steps/activities. Maintenance duties are not usually carried out on all of the parts of an LRU, SRU, component, etc. Rather, the mechanic works on only specific components of the sub-system. For example, when you set the idle on a carburetor, you usually adjust only the idle screw. You do not touch mixture controls, the choke, and/or other components. Therefore, it is not really necessary to have high-fidelity representations of mixture controls and the choke on a training device that was used solely to teach the adjustment of engine idle--one idle screw and a two-dimensional outline of its immediate surroundings would be enough. The challenge to you, then, is to determine exactly what these "important" components are, and, except where other components are needed to help orient the AFSC, represent only those components that are "important" with high-fidelity replicas on your trainer.

The procedures to be described in this section explain how you will decide between including high and low fidelity simulated components on your trainer. By using these procedures, you will be able to determine which components of a device the AFSC really interacts with, and thereby limit high-fidelity representations of components on the trainer to only those components which are absolutely essential to the course's instructional goal.

The following is a general outline of the fidelity definition process:

Substep 1: Identify and Analyze Components

A. Use the Task Level Fidelity Worksheet to determine which components are most crucial to the learning process and therefore need to be present on the training device.

B. Use the Component Fidelity Flow Chart to determine the degree of fidelity that each so-identified component must have.

Substep 2: Combine Fidelity Decisions Within Tasks

A. Review the Task Level Fidelity Worksheet to determine if any components have received different fidelity

recommendations for different skills and knowledge that are all part of the same task.

B. Use the Fidelity Decision Flow Chart to produce one recommended fidelity for each component so that this simulated component can be used to teach all of the skills and knowledge within the task.

Substep 3: Combine Fidelity Recommendations Within Task Groups

A. Fill out and review the Task Group Fidelity Worksheet to determine if any components have received different fidelity recommendations in different tasks that are all part of the same task group.

B. Use the Fidelity Decision Flow Chart to produce one recommended fidelity for each component so that this simulated component can be used to teach all of the skills and knowledge within the task group.

Substep 4: Determine Final Fidelity Recommendations

A. Choose one level (or possibly two different levels) of fidelity to represent each component on the trainer and indicate this choice on FORM 3.

B. Identify on FORM 3 which task each simulated component will be used to teach, which trainer it will be physically attached to, and what function it will perform.

C. Choose what media will be used to represent low fidelity simulated components and indicate this on FORM 3.

Substep 5: Describe Non-Equipment Elements of the Course

A. Go back to the FORMs 2 and identify each behavioral requirement that will not be taught on hardware.

B. Enter each of these skills/knowledge on a FORM 3b, noting what media will be used to teach these training requirements, and what information the media must present to the student (method is selected in Step 9 of this Handbook).

The following sections describe in greater detail the fidelity determination process outlined above:

Substep 1. Identify and Analyze Components

You will need a Task Level Fidelity Worksheet (Figure 20, page 77), the Component Fidelity Flow Chart (Figure 21, beginning on page 78), and the Fidelity Decision Flow Chart (Figure 22, page 81).

For each task scan the FORMs 2 for the specific skills and knowledge that you have determined need to be taught on hardware. Then, go back and reread all of the task descriptive information that you have about the task you are analyzing. These sources include the FORMs 1, LSAs, Technical Orders, or any other information you have about the task that you are teaching. As you read each description, write down the name and/or number of all components that are mentioned in the task description under the "Component" columns of the Task Level Fidelity Worksheet. Also, write down the reference number of the step you are analyzing in Column 10 of the Task Level Fidelity Worksheet. Remember that each component can be involved in more than one behavioral requirement, but should be listed only once on the Task Level Fidelity Worksheet. Whenever you come upon a component that has already been listed, write the Behavioral Requirement identifier in Column 10, but do not write the component name a second time. In other words, a given component should only be listed in one column no matter how many behavioral requirements (rows) it relates to. When you are done, you should have one or more worksheets that list all of the components that are involved with performing the task that you are analyzing. These are the components that you must make fidelity decisions about.

Once you have written down all of the components, the basic question asked for each component is, "What degree of fidelity must this component be simulated with, in order to permit me to teach this skill/knowledge to my students?" You will answer this question by using the Component Fidelity Flow Chart (Figure 21, beginning with page 78). This flow chart divides the fidelity question into three separate concerns:

A. Stimulus Fidelity - What degree of fidelity is needed in order for the simulated component to adequately provide stimuli to the students about the condition of the simulated system they are working on?

B. Response Fidelity - What degree of fidelity is needed in order for the simulated component to be acted upon by the student?

TASK LEVEL FIDELITY WORKSHEET

1 TASK NUMBER	2 TES FORM 1	3. LSA IDENTIFIER AND PAGE NUMBER	4. ANALYST	5. DATE	6. PAGE OF

7. SCHEMATIC, DIAGRAM, PHOTO	8 TES FORM 2 PAGE	9. OTHER SOURCES OF TASK INFORMATION

10 REQ/ REF NUMBER	11 COMPONENT					
FIDELITY 13 EXPLA-NATION						

14 FIDELITY	STIM RESP FDBK	STIM RESP FDBK	STIM RESP FDBK	STIM RESP FDBK	STIM RESP FDBK	STIM RESP FDBK
HIGH						
POSSIBLE HIGH						
POSSIBLE LOW						
LOW						
15 RECOMMEN DATION						

Figure 20. Task Level Fidelity Worksheet

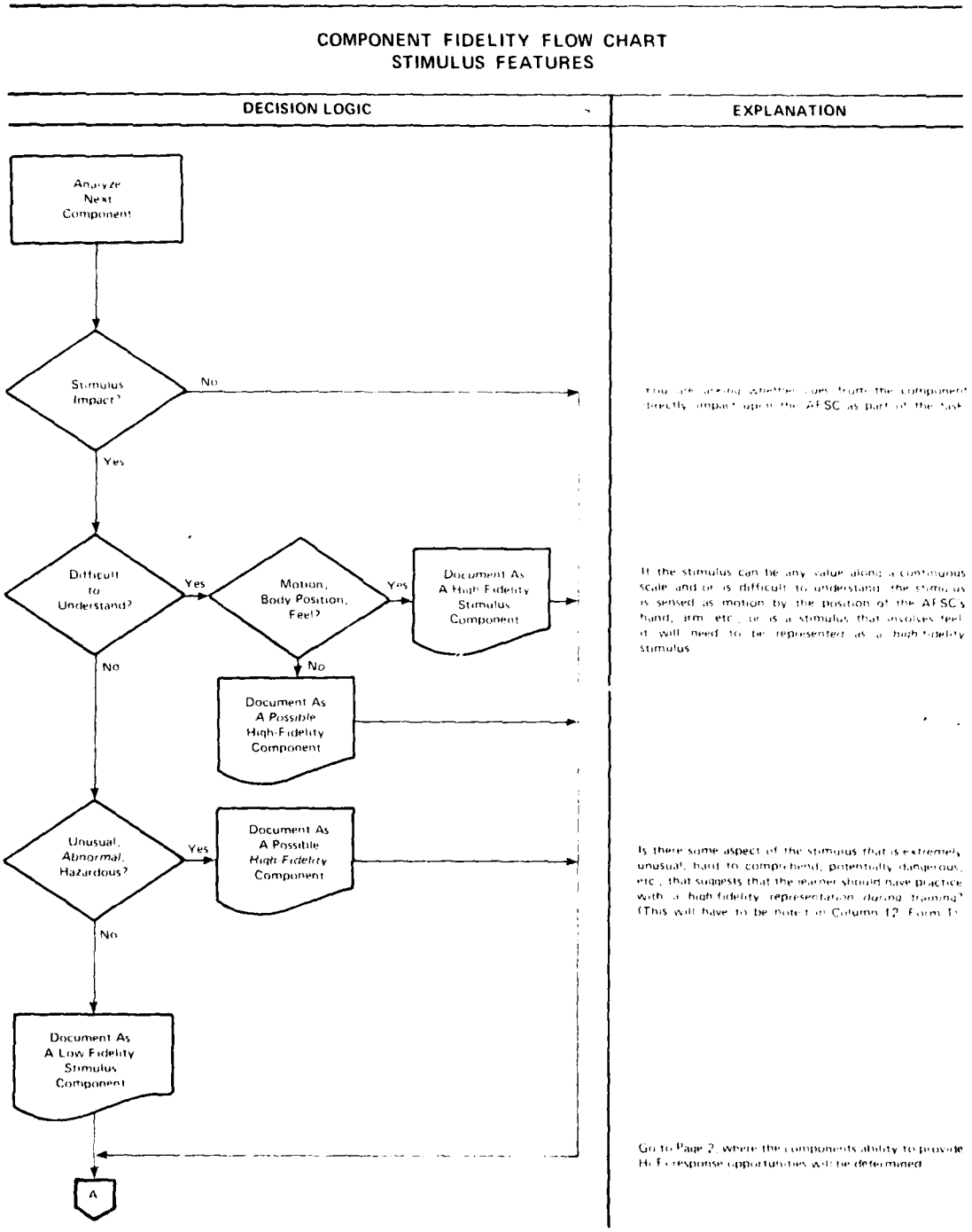


Figure 21a. Component Fidelity Flow Chart

COMPONENT FIDELITY FLOW CHART
RESPONSE FEATURES

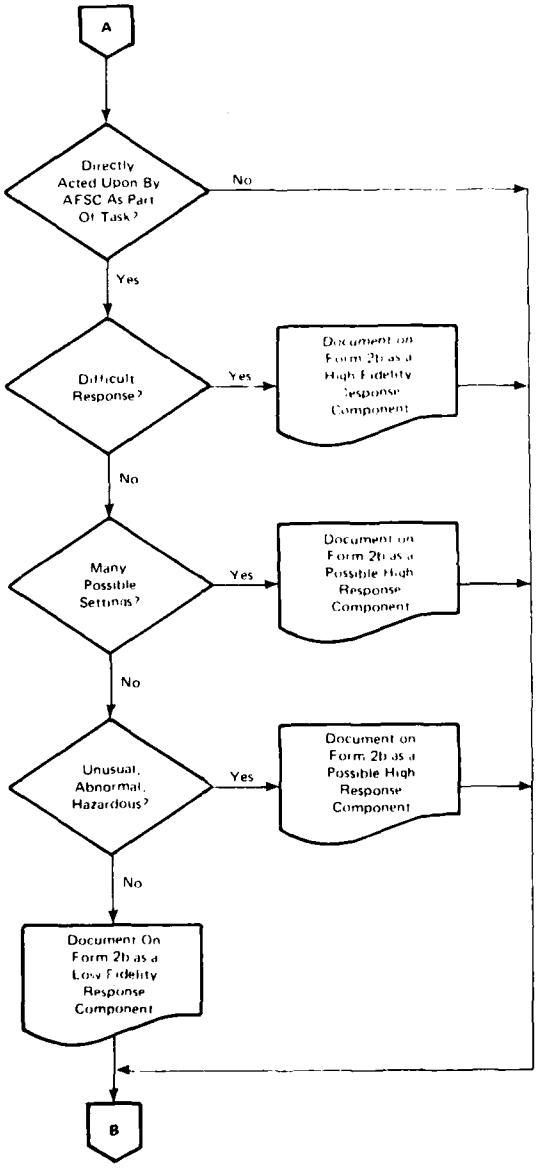
DECISION LOGIC	EXPLANATION
	You are entering with a component whose stimulus properties you have just analyzed. You are essentially asking whether the AFSC lays hands (or tools) on this component. Does the response have to be made in such a way that unaided judgment must be used to determine its adequacy? Is there the possibility that the component could be located, adjusted, or set at many different locations or values? Is there some action in relation to this component that is extremely unusual, hard to carry out, potentially dangerous, etc., that suggests that the learner should have practice with a high fidelity representation of the component during training? (This will have been noted in Column 12, For

Figure 21b. Component Fidelity Flow Chart

COMPONENT FIDELITY FLOW CHART
FEEDBACK FEATURES

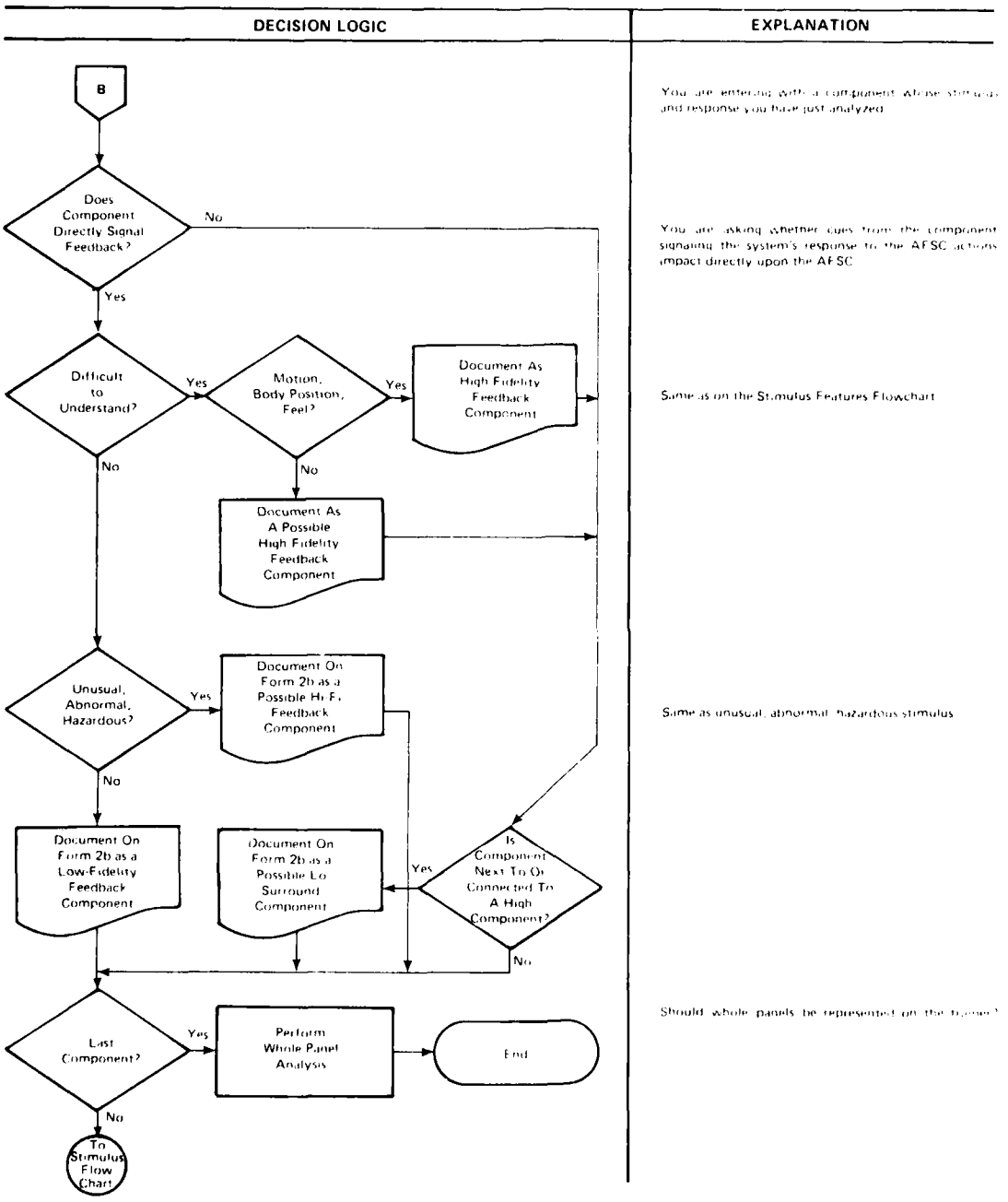


Figure 21c. Component Fidelity Flow Chart

FIDELITY DECISION FLOW CHART

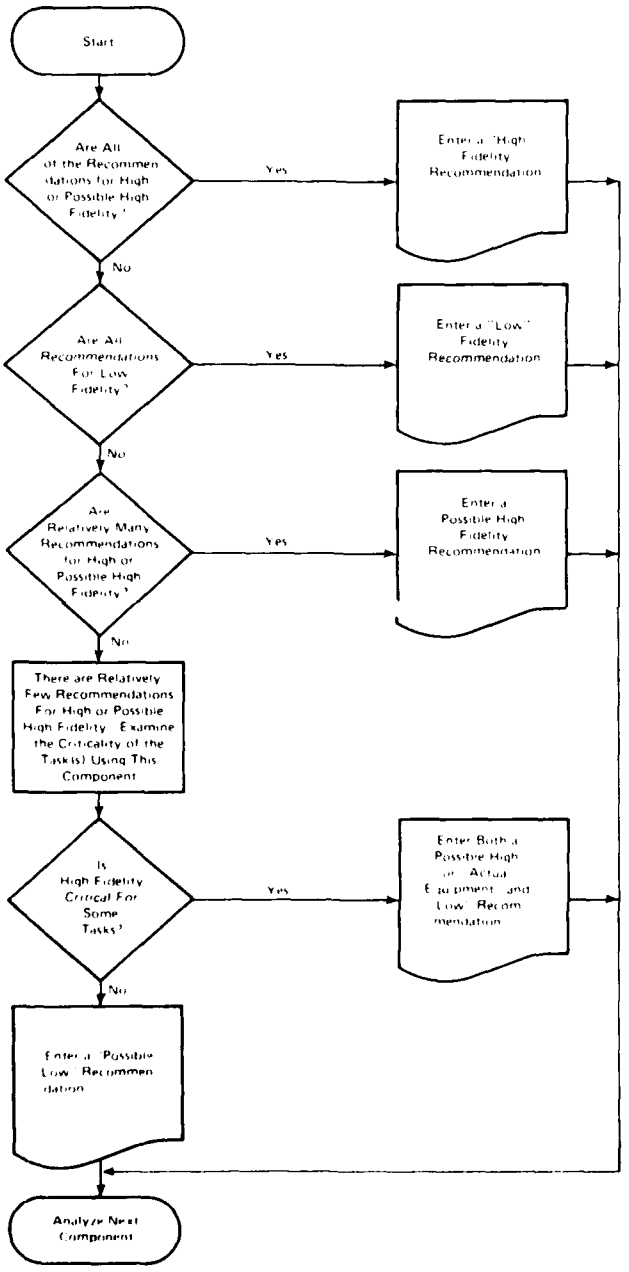


Figure 22. Fidelity Decision Flow Chart

C. Feedback Fidelity - What degree of fidelity is needed in order for the simulated component to provide adequate feedback to the student about the consequences of his actions?

As can be seen, each of these questions analyzes the component from a different point of view. Any simulated system component may act as: (1) a stimulus, that is, something that gives an indication about the weapon's system condition that may require the AFSC's attention; (2) a response, something that the student must actually remove, replace, adjust, align, test, etc., or (3) a feedback mechanism, something that changes as a result of the student's actions.

For example, a simulated navigational system failure light is a component that has stimulus features--it signals that something is wrong. The simulated navigational system black box might then be thought of as a response component, since, it is something that the student will be directly acting upon. Finally, a simulated green navigational system "Ready" light might be thought of as a feedback component, since it responds to the student's replacement of a defective black box with a "Ready" signal.

Given the fact that at any given time each component on the weapon's system may have stimulus, response, or feedback functions, you must analyze each component considering first the stimulus properties, next the response properties, and finally the feedback properties. This will assure that the component, when represented on the trainer, has all the properties or features required to teach the desired skills and knowledge. The routine to do this is outlined in the Component Fidelity Flow Chart (Figure 21, page 78 to 80). You start your analysis on the Stimulus Features page.

Stimulus Features Flow Chart: Each entry below corresponds to one of the questions that you must answer in order to fill out the Task Level Fidelity Worksheet. You will ask these questions for each component that you analyze:

A. STIMULUS IMPACT? Determine whether the component that you are analyzing has any stimulus impact on the AFSC. That is, does he have to examine the status of this component in order to carry out the maintenance task or receive information to evaluate a malfunction. Some questions you might ask yourself which, if answered "Yes," indicate the component does have stimulus impact include:

1. Is this a dial or gauge which is examined for a certain reading?

2. Is this a signal light or buzzer that must be looked at to see if something is on or off?

3. Is this a component that must be examined for leaks, cracks, discoloration, dents, stripped wires, etc.?

4. Is this a component whose movement must be tested to find out if it moves the proper way?

5. Is this a component that must be looked at to determine if it is vibrating, humming, jerking, or out of alignment?

If the answer to any of these questions is "Yes," then the component you are considering does have stimulus impact and you must go through the rest of this flow chart. If the answer is "No," you can branch around the Stimulus Features Flow Chart and go on to the Response Features Flow Chart described on page 79.

B. DIFFICULT TO UNDERSTAND? Determine whether the stimulus this component provides is exact, and, therefore, easy to understand. For example, a digital readout is very easy to understand because you can immediately or directly perceive what the reading is. A dial readout is more difficult to understand because it is hard to determine exactly where on the dial the pointer is aimed. Even less understandable are more "continuous" scales such as "big dents" (when is a dent large enough to be "big?"), smudges on laser windows (how much blurriness classifies a spot as a "smudge?"), and "abnormal" vibration (how much vibration is "abnormal?"). In all of these cases, the component may be signalling a condition that is difficult to judge with certainty. At this point in the flow chart, decide if this is the case with the component you are analyzing. If it is, take the "Yes" path. If the condition the component is signalling does not appear difficult to understand (for example, it is merely an idiot light, a digital readout, or an easily-understood dial reading), take the "No" path. Difficulty must be determined in light of the background of the target population.

C. MOTION, BODY POSITION, FEEL? This question goes further into the issue of how difficult the stimulus is to evaluate. In general, stimuli that involve sensing a certain degree of motion, determining the position of your own body in holding a component, or feeling the texture of

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UNCLASSIFIED AFHRL-TP-81-51 NL

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AD A
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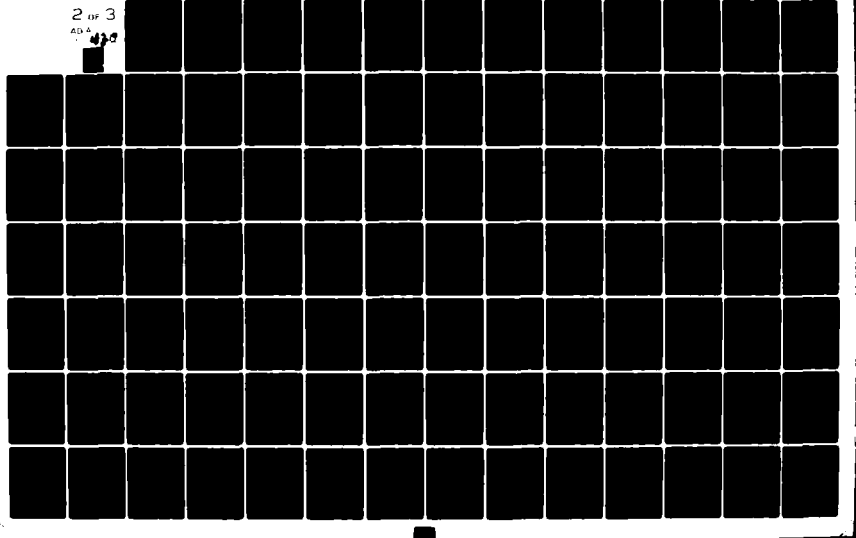
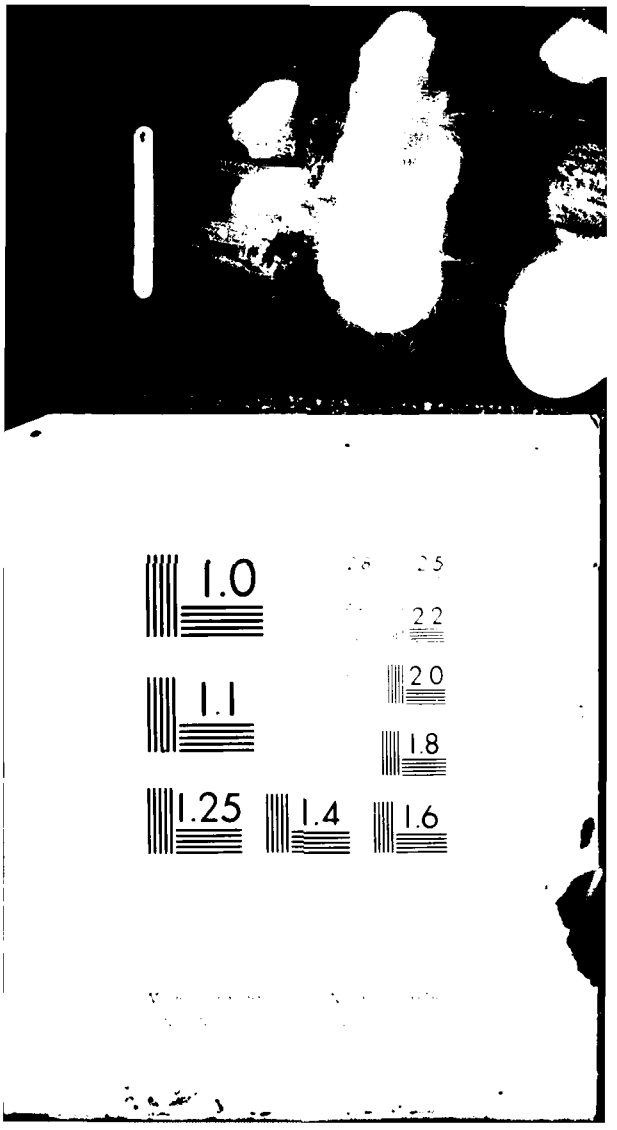



1.0
1.1
1.25
1.4
1.6
2.2
2.0
1.8

a component, are significantly harder to be certain about than other kinds of stimuli. For example, you may have to determine whether a surface is "pitted." How much roughness constitutes "pitting?" Probably the only way the student can learn to discriminate this degree of roughness is to actually feel samples of the component which have been roughed up to different degrees. Then, through repeated trials, he should acquire the ability to discriminate the degree of deterioration that necessitates the replacement of the component. Therefore, if sensing something about a component includes motion, body position, or feel, you should definitely document the component as requiring a high fidelity representation on the training device. To do this, enter an "H" on the first of the three lines under the component listing of the Task Level Fidelity Worksheet (see Figure 23 below).

	COMPONENT		
Req/Ref Number	AN-PSC-8715-17 Laser Window		
Fidelity Explanation	H Glass Cover (Stim.)	(Resp)	(Fdbck.)

Figure 23. Documentation of the Stimulus Fidelity Decision Example

Whenever you indicate that a component must be represented with high fidelity, you must also explain exactly what aspect of the component needs to be represented in that way. In the example above, the only part of the laser window that needs to be represented with High Fidelity is the glass cover itself, since this is the only part of the window assembly that needs to be checked for pitting or smudges. Therefore, you should write a description or justification of exactly what aspect of the window needs to be represented on the trainer. This kind of explanation is probably rarely needed if a low fidelity representation is required.

D. UNUSUAL, ABNORMAL, HAZARDOUS? If you answered "No" to the "Difficult to Understand" question, you must then ask yourself whether there is something unusual, abnormal, or hazardous about working with the component you are analyzing. Some of the things that fall into this category include:

1. Electrical hazards.

2. Dangerous chemicals, fuels, exposives, etc.

3. Components that may suddenly move or jerk.

4. Maintenance tasks or activities that are very rarely performed.

5. Tasks or activities using new and/or modified tools.

6. Tasks that may require very close coordination among a number of mechanics.

7. Tasks or activities which have to be done very quickly or closely coordinated with other tasks.

8. Emergency procedures that are rarely performed.

Looking over the above list, it is clear that you must use your own judgment and experience in determining whether you should answer "Yes" or "No" to this question. Your basic criterion should be: "Given all of your knowledge and experience, do you feel that the work with the component you are analyzing is so unusual, abnormal, or dangerous that the students should be taught on high-fidelity hardware?" If so, then you should answer "Yes" to this question and write "PH" for Possible High Fidelity on the proper line of the Task Level Fidelity Worksheet. Also, enter a brief explanation as you did for the High Fidelity recommendations.

If the work with the component you are analyzing is neither difficult to understand nor unusual, abnormal, or hazardous, the component should be represented with Low Fidelity on the trainer. Enter an "L" on the proper line of the Task Level Fidelity Worksheet. Once you have done this, you have completed the Stimulus Features Flow Chart and are ready to begin analyzing the component's response characteristics with the Response Features Flow Chart.

However, before describing the Response Features Flow Chart, a further word has to be said about Low Fidelity components. It is expected that the components given Low Fidelity ratings will typically be idiot lights, digital readouts, dials, etc. The reason that they require low rather than high fidelity representation is that they are neither hard to understand nor unusual, abnormal, or hazardous. Such components, therefore, do not have to appear in their "real" form. For example, rather than having an idiot light on the trainer, you could just as easily project a message on the student station CRT saying that the light was on. The student, in many cases, could learn the task just as well. However, while this does suggest that you wouldn't necessarily want to use the real idiot light on your trainer, you should consider using the real component if a simulated substitute of less fidelity is no cheaper or easier to fabricate. For example, an idiot light is a relatively inexpensive device. If you have already decided that it must appear on your trainer in some form, you should ask yourself whether there is any great drawback to using a light identical to the one that really exists on the aircraft. If there is no penalty, you may as well use an actual light, even if your analysis indicates that you can use a low-fidelity representation.

In other words, it is important to make reasonable, common-sense decisions with this procedure. The major reason for having a low-fidelity category is that many components on an aircraft are not simple or inexpensive to fabricate and it may not be essential that they appear with full fidelity in order to teach a particular skill or knowledge. These are the parts that should be represented with low-fidelity training components. However, for those components which are inexpensive or readily available, you may want to use the actual component or a high-fidelity representation of it simply because you can do so inexpensively and easily. If this is the case, then by all means do so.

Response Features Flow Chart: Once you have completed the Stimulus Features Flow Chart, you must then anal[illegible]ze each component using the Response Features Flow Chart (Figure [illegible]ge 79). Each question asked in this flow chart is described bel[illegible]

A. DIRECTLY ACTED UPON? The Response Features Flow Chart is quite similar to the Stimulus Features Flow Chart in concept. First, you must decide whether the component you are analyzing is acted upon in some way by the AFSC in carrying out the maintenance task; that is, must the AFSC "respond" in some way by working on the component? If you can answer "Yes" to any of the following, you should answer "Yes" to the overall question:

1. Does the AFSC remove or replace the component?

2. Does the AFSC align, adjust or set a value or position on the component?

3. Does the AFSC clean the component?

4. Does the AFSC fit, file, or cut the component?

5. Does the AFSC fill or empty some substance into or out of the component?

If you answered "No" to all of these questions, then you have determined that the AFSC does not work directly on the component you are analyzing and you should go on to the Feedback Features Flow Chart described on page 80.

B. MANY POSSIBLE SETTINGS? Basically, this question deals with the fact that some components (switches and dials especially) can be set at several different positions, and across all of the maintenance tasks that are included in the training course, such indicators may actually have to be set at many of these positions. Given this situation, it would probably be easier from a practical point of view to use a single high-fidelity representation of the component. This would allow the AFSC to actually set all of the positions and would be more efficient than a series of low-fidelity representations, each of which stood for only one position. Therefore, you should ask yourself if the component you are analyzing can be set at many different positions or values. If your answer is "Yes," then you should enter a "PH" for Possible High on the Task Level Fidelity Worksheet and enter your reason for this decision in the "Explanation" area. If your answer is "No," go on to the next question.

C. UNUSUAL, ABNORMAL, HAZARDOUS? This is the same question that appeared on the Stimulus Features Flow Chart and

should be answered in the same way. If your answer to this question is "Yes," then you should enter a "PH" on the Task Level Fidelity Worksheet. If your answer to the last question is "No," then you have determined that this component is acted upon by the AFSC, but does not require a difficult response, it is not unusual, hazardous, or abnormal, and it does not potentially involve many possible settings. Under these circumstances, there is no need for the component to be represented with high-fidelity. You should, therefore, enter "L" for Low-Fidelity on the Task Level Fidelity Worksheet, then continue on to the Feedback Features Flow Chart (Figure 21c, page 80).

Feedback Features Flow Chart: The questions guiding fidelity determination for the Feedback Features Flow Chart are described below:

A. DOES COMPONENT DIRECTLY SIGNAL FEEDBACK? Does the component, during the actual maintenance task, respond to the mechanic's actions in some way that signals the system's status or guides the mechanic's next action. Some examples of this feedback action are:

1. A light that goes on or off as a result of the mechanic's maintenance action.

2. A dial or indicator that changes values as a result of the mechanic's maintenance actions.

3. A component that moves in or out, or changes alignment or adjustment as a result of the mechanic's maintenance actions.

4. A component that performs its normal function such as a certain movement, operation, or alignment as a result of the mechanic's maintenance actions.

If the component acts in any of these ways during the normal maintenance sequence, then it is a feedback component and must be analyzed further. If it has no such function, then you can branch around most of this flow chart and go on to the "Immediate Surround" question.

B. IS COMPONENT NEXT TO OR CONNECTED TO A HIGH-FIDELITY COMPONENT? You should be analyzing every component that is mentioned in the task description of the maintenance sequence that you are working on. In many cases, however, a component may be mentioned in the task description that

has neither stimulus, response, or feedback features. It is merely next to or connected to components that do have direct relevance. If this is so, it is very unlikely that there would be any need to represent this component with high-fidelity. However, it might be quite helpful to the student if it is represented with low-fidelity so that the student will have a better understanding of the physical layout of the system he is learning to work on.

Therefore, if the component you are addressing is near or connected to a high-fidelity component, enter a "PL" for "Possible Low" on the Task Level Fidelity Worksheet. If you think the component is not of sufficient importance to be represented on the trainer at all, simply eliminate it from any further consideration and go on to analyze the next component that is mentioned in your task analysis data.

C. DIFFICULT TO UNDERSTAND? This question should be answered in the same way that you answered this question on the Stimulus Features Flow Chart.

D. UNUSUAL, ABNORMAL, HAZARDOUS? This question should also be answered in the same way that you answered it on the Stimulus Features Flow Chart. If the component you are analyzing has feedback features but you have answered "No" to the "Difficult to Understand" and "Unusual, Abnormal, Hazardous" question, then the component needs to be represented with low-fidelity only, and you should enter an "L" on the Task Level Fidelity Worksheet in the feedback column.

E. WHOLE PANEL ANALYSIS. The last thing that you must do as part of the task level fidelity determination is the Whole Panel Analysis. This analysis is really very simple and is intended to make your trainer appear as realistic as possible at minimal expense. This analysis addresses the completeness of the subsystem panels that will appear on your trainer. That is, most trainers will include at least some dials, switches, lights, etc. from the weapons system or from portable test equipment which is utilized in performing the maintenance task. Also, airplane cockpits are typically arranged by grouping the components associated with one particular aircraft subsystem near each other on one or two panels devoted only to that subsystem.

Depending upon the maintenance tasks that your course is designed to teach, many of the components on the panels you are dealing with will need to be represented (with either high or low-fidelity) on the trainer. However, what about the remaining components on the panel? What should you do with the fifth component if four of the five components on a panel are required to appear? It is suggested that in cases such as this, the additional component should be included on your trainer even if it is not specifically needed, as long as there is no significant cost required to include it; i.e., if it is not functionally represented and only needs to be represented physically.

There are two reasons for telling you to include these "extra" components. First, it will make the panel look more realistic to the student which is always desirable if such realism does not substantially add to the cost of the trainer, or distract the student with too much information in the early stages of training. Secondly, the inclusion of a modest number of nonessential components should not add significant material costs, since you can represent the additional components with two-dimensional drawings or pictures that are reasonably inexpensive to develop. Also, you may have decided to use an actual piece of equipment to represent all of the necessary components. If so, it may actually require more time and money to fabricate a simulated panel without the nonessential components than simply to use a real panel which had the unneeded portions disconnected or in some other way deactivated. As an ISD analyst you may not be in a position to estimate or determine cost issues. However, this does not invalidate the procedure being suggested. You should still ask yourself whether or not adding other components will contribute to learning.

Therefore, the Whole Panel Analysis is a check to see which panels have the majority of their components represented on the trainer. Where this is the case, you should ask yourself if it would be of benefit to the student to include the component, but at a low degree of fidelity.

The following steps summarize the Whole Panel Analysis:

1. Obtain drawings or photographs of all of the systems, panels, etc. that your course will deal with.

2. Note which components of each subsystem or panel have been included on the panel or subsystem.

3. Step back and assess at the whole panel or whole subsystem containing the components mentioned in Step (2) above. Identify those components that are part of the panel subsystem but have not been included on the trainer.

4. Determine the best way to represent the non-included components. These methods might include:

   (a) Drawings.
   (b) Photographs.
   (c) Decals.
   (d) Etchings.
   (e) Use of an actual equipment panel that already includes the extraneous components.

5. Write in the component names and numbers on the Task Level Fidelity Worksheet and specify the associated degree of fidelity (Low) as you did with the other components.
   When you have completed the Whole Panel Analysis, you will probably have added at least some components to your trainer which make the trainer more realistic and helpful at little added expense. It is expected that most panels will therefore have all of their components represented on the trainer at some degree of fidelity.

Substep 2. Combine Fidelity Decisions Within Tasks

Once you have finished the Whole Panel Analysis, you have finished the component fidelity determination process at the behavioral training requirement level. However, since many components are involved in the teaching of more than one skill or knowledge within any given task, a given component may have had a different fidelity specified for each of the different skills and knowledges it is associated with. Your job is to determine a single level of fidelity for the component to be used in teaching all of the skills and knowledges in the task.

Rows 14 and 15 of the Task Level Fidelity Worksheet (Figure 20, page 77) and the Fidelity Decision Flow Chart (Figure 22, page 81) will be used to make this decision, following the procedure presented below:

A. Fill out Row 14. This will involve counting how many times each component receives a particular fidelity recommendation. For example, if a given component has received two High fidelity recommendations for Stimulus functions and does not have a Response or Feedback function on the trainer, then the first line of Row 14 would look like this:

High 2 0 0

If this particular component has also received one Low-Fidelity Stimulus recommendation and no other recommendations of any type, Row 14 should look like the following (you may want to leave blanks rather than writing in zeros):

FIDELITY	STIM	RESP	FEEDBACK
High	2	0	0
Possible High	0	0	0
Possible Low	0	0	0
Low	1	0	0

Figure 24. Sample Row 14 of Task Level Fidelity Worksheet

B. Now that Row 14 is filled out, you must resolve any conflicts that appear between H, PH, PL, and L fidelities. As can be seen from the above examples, such a discrepancy does appear in the STIM column. To resolve this conflict, simply go through the Fidelity Decision Flow Chart (Figure 20, page 77) and enter the outcome of this process on the correct line of Row 15, "Recommendation." Remember, however, that a component will always have either a Stimulus, Response, or Feedback function. Leave the recommendation area blank for those functions not performed by the component you are analyzing. For example, the final recommendation for the above example would appear as:

15. Recommendation H (blank) (blank)

Continue to perform Steps 1 and 2 for all of the components within the task. When you are done, you should have one set of fidelity recommendations for the entire task reconciling any differences between the various fidelity

recommendations made for teaching individual skills and knowledge within that task. Your next job will be to perform the same kind of reconciliation between different fidelity recommendations that have been made on the same component for different tasks.

If you are an experienced analyst you may find the procedure specified above laborious and extremely detailed. The degree of detail specified is needed in order not to overlook anything; i.e., to assure that all features of components being represented impact or assist the learning of the skills and knowledge. The procedure specified above requires the analyst to identify every component and examine how each skill and knowledge impacts on that component in terms of the component having stimulus, response, and feedback characteristics. An experienced analyst (one extremely familiar with the system or subsystem being simulated, and with instructional design) might find it more appealing and practical to work in reverse. That is, the analyst may first list all the components in the performance of the task, then ask, for each component, whether the component serves as a stimulus, response or feedback for the task performer. If the component serves as a source of stimulus, response, or feedback, then identify what aspect of that component must be represented on the trainer to serve that particular function. This information can then be directly recorded on FORM 3a. If the experienced analyst adopts this approach he should check the FORMs 2 to be sure that there is a skill or knowledge associated with the component and the to-be-represented feature. It should be noted that this procedure also eliminates the reconciliation procedure within tasks specified above.

Substep 3. Combine Fidelity Recommendations Within Task Groups

This process involves reconciling different fidelity recommendations between different tasks and is conceptually the same as the reconciliation process at the task level. The only difference is that the task level procedure reconciles differences between component fidelity recommendations made at the skill and knowledge level in order to decide upon a fidelity that can be used to teach an entire task, while this substep reconciles component fidelity differences at the task level in order to decide upon a fidelity that can be used to teach an entire task group. You will need your completed Task Level Fidelity

Worksheets (Figure 20, page 77), the Fidelity Decision Flow Chart (Figure 22, page 81), and a supply of blank Task Group Fidelity Worksheets (Figure 25, page 95), to complete this step. The procedure you will follow involves the following steps:

A. Enter the name and number of each component and its recommendation from Row 15 of the Task Level Fidelity Worksheet on the Task Group Fidelity Worksheet. Remember to use only one column for each component, listing all of the tasks in which it appears on separate rows of that column.

B. Enter the total number of H's, PH's, PL's, and L's for each component in the summation area at the bottom of the FORM.

C. Use the Fidelity Decision Flow Chart (Figure 22, page 81) to reconcile any differences in recommendations and arrive at a final recommendation for this component for the entire task group. Write this in the "Recomendations" row of the FORM.

D. Repeat steps A - C for all of the components that are listed on the Task Group Fidelity Worksheet.

Substep 4. Determine Final Fidelity Recommendations

You have now determined what level of fidelity each simulated component must have for each of the task groups in which it appears. However, components are used in more than one task group and may have different recommended fidelities for each task group. Therefore, you must examine the recommended fidelities for a component across task groups to see if there are any discrepancies, and, if there are, reconcile them so that you can decide upon a final degree of fidelity for each component that will appear on the trainer. You will need the completed Task Group Fidelity Worksheets (Figure 25, page 95), the Fidelity Decision Flow Chart (Figure 22, page 81), and a blank FORM 3a (Figure 26, page 96) to complete this procedure. The following are the specific steps you must take:

A. Write the component number and name in Columns 4 and 5 of FORM 3a.

B. Examine the fidelity level selected for the component for each of the task groups in which it appears. If the fidelities are the same, simply enter that fidelity in Column 6. If the fidelities are not the same, there are two options available to you:

TASK GROUP FIDELITY WORKSHEET

1. TASK GROUP	2. DATE	3. ANALYST'S INITIALS	4. PAGE OF

5. TASK	6. COMPONENTS																	
FIDELITY 7. EXPLANATION																		
8. FIDELITY	STIM	RESP	FDBK	STIM	RESP	FDBK	STIM	RESP	FDBK	STIM	RESP	FDBK	STIM	RESP	FDBK	STIM	RESP	FDBK
HIGH																		
POSSIBLE HIGH																		
POSSIBLE LOW																		
LOW																		
9 RECOMMEN DATION																		

Figure 25. Task Group Fidelity Worksheet

1. COURSE NO.		2. ANALYST			3. DATE	4. PAGE OF
4. COMPONENT NO.	5. COMPONENT NAME	6. FIDELITY — — —	7. RELEVANT TASKS	8. TRAINER USED ON	9. SPECIFIC CHARACTERISTICS THAT THE COMPONENT MUST HAVE	

FORM 3a

Figure 26. FORM 3a

1. Use the Fidelity Decision Flow Chart (Figure 22, page 81) to decide upon one level of fidelity which will be used for the entire course, and enter this recommendation in Column 6. However, make sure you are satisfied that you can meet your training objectives by using only a single level of fidelity. You may have to review some TOs, FORMs 1, or LSAs in order to do this. It is important to note that this step puts a premium on your judgment. If you feel strongly that you cannot use just one version of the simulated component to teach all of the associated skills and knowledges, you should use two levels of fidelity and document this decision according to the second option described directly below.

2. If you choose to use this option you have decided that you cannot identify a single level of fidelity for the simulated component that will adequately teach all of the skills and knowledge requirements associated with it. Rather, you have determined that the component will be represented by two different simulations, each at a different level of fidelity. Therefore, you must enter the component number and name a second time in Columns 4 and 5 of FORM 3a and indicate the appropriate fidelity level of each in Column 6.

Alternatively, you might devise a way to alter a high-fidelity component for the occasions when a lower fidelity is needed to acquire a specific training requirement. For example, you may take a full scale dial and change the face so that not all the scale points are represented.

C. You must now identify which tasks each simulated component will be used to teach. You already have this information on your Task Level Fidelity Worksheets. Therefore, simply go through these worksheets to determine which tasks the component appears in and list these tasks next to the component in Column 7. You should enter one task per line in Column 7.

D. The chances are that you have only designed one trainer to use for your entire course. However, you may decide to divide the simulated components up into groups, and

therefore create two or more trainers, for a number of reasons. If you do so, you should indicate which trainer each simulated component will be mounted on. Simply think of one trainer as trainer "A", the second as trainer "B", etc. Enter the appropriate letter in Column 8. If you have chosen to use only one trainer, simply leave Column 8 blank.

E. You must now describe the simulated component in detail, including the external appearance and simulated functions. It is this description that will be the primary input to the actual manufacturer of the trainer. Therefore, your goal in filling out this section of the FORM is to provide enough information so that the manufacturer can build the trainer to appear and act in exactly the manner you have determined it should.

High Fidelity Simulated Components: The description written here should be based upon the short explanations of your fidelity decisions entered earlier on the Task Level Fidelity Worksheets. You might also want to reference any drawings, functional descriptions, or other sources of information that could aid the manufacturer in his task. The following are some of the kinds of information you may want to include in this section:

A. External physical appearance of the simulated component.

B. Operating and non-operating segments of the simulated components.

C. Specific movements, adjustments, etc. that the simulated components must be capable of reproducing.

D. Specific normal and malfunction states the simulated components must be capable of reproducing.

E. Specific values of dials, pointers, readouts, etc., that simulated components must indicate in order to signal specific states of the simulated air vehicle.

Low Fidelity Simulated Components: Once you have described the appearance and function of the High fidelity simulated components, choose the appropriate media to represent each of the Low fidelity components that you intend to include on your trainer. The procedure to do this is simple and straightforward. Simply go through your FORMs 3a to find each component that will be represented with a low fidelity device. Then, for each one, determine which of the following categories the component and its use fall under:

A. Stimulus - Visual.
B. Stimulus - Audio.
C. Stimulus - Audio/Visual.
D. Response - Audio/Motor.
E. Feedback - Visual.
F. Feedback - Audio.

Once you have made this determination, turn to the "List of Low Fidelity Alternatives" on Table 4 (page 100). The list presents other media classes that you can use to represent low fidelity components as a function of which of the above six categories the component belongs in. Find the proper category in the Table and choose the medium in this category that seems to be most appropriate to the portrayal of the particular component that you are analyzing. Some criteria you could use in choosing the appropriate media include:

A. Compatibility with the high fidelity components.

B. Cost (if known or be easily estimated).

C. Speed and simplicity of production.

D. Availability of media presentation devices already used by other portions of the course (filmstrip projectors, CRTs, tape players, etc.).

E. Availability of the instructor to present or control the information.

Finally, enter the title of the medium (line drawing, chart, signal light, etc) that you plan to use in representing the component in the last column of FORM 3a, and describe exactly what purpose the representation is to serve. Your description should conform to the requirements of the current FORM 3 as outlined in the 3306th Procedural Handbook (page 90).

Substep 5. Describe Non-Equipment Elements of the Course

During your analysis of each skill and knowledge on the FORM 2, you divided all of the skills and knowledge into those that needed to be taught on some type of hardware device and those that could be taught on some other media. Then, using the flow chart entitled, "Selection of Media Other Than Hardware," (Figure 17, page 60) you chose a medium to present the training material. Transfer each of these entries to a FORM 3b, (Figure 27, page 101 for a sample FORM) listing the task and

Table 4

LIST OF
LOW FIDELITY ALTERNATIVES

I. Stimulus - Visual

Line Drawing
Chart
Transparency
Signal Light
Photograph (b/w, color)
Slide Random Access Projecto
Filmstrip
Photo Etching or Engraving
Dummy Component
(manufactured look alike; may be replaceable but not functional)
Model (variation of scale possible)
Mock-Up (nonfunctional, cutaway)
CRT (Computer Image Generation; preprogrammed scenarios)*
Animated Display Panel

Stimulus - Audio

Tone, Buzzer, Bell, Alarm
Tape Recording

Stimulus - Audio/Visual

Video Tape
Closed Circuit TV
Film
Slide Tape Deck

II. Response - Audio/Motor

Verbal
Point
Button (hand or foot operated)
Decision Indicator:
Light/Sonic Pen
Punchboard/Tab Techniques
Keyboard/Terminal
Toggle Switch
Rotary Selector Switch
Knob
Thumbwheel/Handwheel
Crank
Lever
Pedal

III. Feedback - Visual

Punchboard/Tab Techniques
Signal Light
CRT/Terminal Display
Print-out

Feedback - Audio

Instructor
Tone, Buzzer, Alarm, Bell
Tape Recording

*A detailed presentation of visual image display systems is available in ASD-TR-78-16, Air Force Aircrew Training Devices Master Plan, March 1979.

Note: A description and evaluation of some of these items appears under the media descriptions Appendix A.

1. ANALYST	2. DATE	3. PAGE OF

4. TASK & REQ. NUMBER	5. MEDIA	6. DESCRIPTION/BEHAVIORAL REQUIREMENT

FORM 3b

Figure 27. FORM 3b

requirement number, the media that you have selected, and a description of the behavioral requirements that the media should support. This description should conform to the description now entered onto the current FORMs 3 described in the 3306th Procedural Handbook.

Products of Step 6: Once you have completed Step 6, you should have the following completed documents:

- FORM 3a - A listing of each component that needs to be represented with hardware, including a specification of what fidelity (High or Low) the simulated component should have, what task(s) it will be used to teach, what trainer it is attached to, and a description of each component's appearance and operation.

- FORM 3b - A listing of each behavioral requirement that does not require training, and a description of what the alternative media should present.

The next step deals with the selection of instructional features for the trainer.

- ☐ STEP 1 Identify System Maintenance Requirements
- ☐ STEP 2 Identify Characteristics of the Target Population
- ☐ STEP 3 Determine Training Requirements
- ☐ STEP 4 Determine the Type of Technical Training Materials Required
- ☐ STEP 5 Sequence Skills and Knowledge (Utilization Plan)
- ☐ STEP 6 Identify Fidelity and Simulated Features
- ■ STEP 7 Select Instructional Features
- ☐ STEP 8 Prepare ISD Specification
- ☐ STEP 9 Identify Method
- ☐ STEP 10 Prepare Course Control Documents (CCD'S)
- ☐ STEP 11 Prepare Instructional Materials and Tests
- ☐ STEP 12 Validate Instruction
- ☐ STEP 13/14 Conduct Training and Evaluate Training

STEP 7. SELECT INSTRUCTIONAL FEATURES

At this point in the procedure you have determined the number of trainers you will need and you have determined the degree of fidelity of each component on the hardware trainer(s). You are now ready to select instructional features for your hardware media. You will only need to perform this step for a sophisticated trainer. If your hardware media is only a mock-up or a working model, then typically instructional features will not be needed. If your trainer involves some sort of complicated student instruction, then instructional features need to be selected.

Neither AFP 50-58 nor the 3306th Procedural Handbook discuss instructional features. The selection and use of instructional features is a new area.

To understand what instructional features are and how they can be used, it is necessary to have an understanding of how people learn. Educational and psychological research has identified some basic learning principles. Although more research needs to be conducted, learning is seen as involving four components, steps, or aspects. There is the stimulus (the problem to be solved or fact to be learned), the response (the student's action or actions to the stimuli), the feedback (the information given to the student concerning how his response compares to the desired response) and the next activity (the selection of what the student should do next). Each learning situation then involves: (a) control over the stimulus presentation, (b) control over recording of the student responses, (c) control over presenting the student with augmented feedback information and (d) control over the next activity selected. These aspects of learning are involved in every learning situation, whether the learning is simple or difficult. No matter how simple or complex the learning situation is, someone or something must have control over the stimulus, over when and what to record, over what information is given to the student after each response, and over what the student should do next. There are three primary sources of control: the instructor can control these aspects of the learning environment, the trainer can have control over them, or in some cases the student might be given such control. In the typical instructor-oriented lecture the instructor controls all of these aspects of the learning environment. The instructor controls the rate of stimuli presentation, he controls what responses are recorded, and he decides what the next learning activity will be.

When dealing with sophisticated trainers or simulators it may be advantageous to have the trainer control some of these functions. For

example, if the student must make a series of rapid responses, it may be too difficult for the instructor to record these responses accurately by observation, thus it may be preferable to have the machine or trainer record these responses rather than the instructor. When the trainer is given these kinds of responsibilities or capabilities, the trainer is said to have instructional features. That is, the trainer has devices or mechanisms to control certain aspects of the learning environment. It should be understood that the machine or trainer is given these responsibilities by the designer. For example, the designer must tell the machine the rate at which to present the stimuli; the machine or trainer does not inherently know this. Thus, although the trainer or machine is controlling aspects of the learning environment, it is the designer who sets the parameters of the control device or mechanism.

Instructional features then, are features (characteristics) of the trainer (hardware) that control the stimuli, the responses, the augmented feedback and/or the next activity aspects of the learning environment. It should be pointed out that the four aspects of the learning environment must be controlled by someone or something. All four ingredients must be present in the learning environment, regardless of who has control over them. Instructional features are <u>not</u> something that make learning easier, they are things that are controlled by the machine or trainer, which could be controlled by the instructor.

As you will discover in this section, the type of behavior you are accomplishing with your trainer (hardware) influences the nature of the stimulus, response, feedback, and next activity controls selected. That is, control over these aspects of the learning environment varies with the type of behaviors you are using your trainer to achieve.

For example, when teaching discrimination behavior, it is important to control the stimulus. That is, it is important to vary the number of characteristics that the stimulus displays. However, when teaching rule using, this aspect of the learning environment may not need to be controlled. You will see that instructional features are related to the way certain behaviors are taught; that is to learning principles associated with each behavior.

This section presents a technique to select those instructional features that are absolutely necessary. The technique forces a decision between having the instructor control certain aspects of the learning environment or having the machine or trainer control them. It should be recalled that instructional features can increase the cost of the trainer and should only be used when the situation dictates that the instructor <u>cannot</u> control these aspects of the learning environment.

To select the instructional features for your trainer, you will need the Learning Principle Guidelines (Appendix B), Instructional Features Worksheet (Figure 28, page 107), and FORM 4 (Figure 29, page 108).

First, look over the Learning Principle Guidelines. You will see that each taxonomic element or behavioral classification has its own set of learning principles. That is, each behavioral classification involves a unique set of learning principles. Each guideline is written in the same way: there is a definition of the behavior, a brief description of the practice situation, a stimulus section (which indicates if highlighting is needed, if the rate of stimulus presentation needs to be controlled, and if the signal-to-noise ratio needs to be controlled), a response section (which indicates what aspects of the behavior can be measured), a feedback section (which indicates the augmented feedback schedule and the content of the augmented feedback message) a description of what the next learning activity should be, depending on the student's response, and a miscellaneous category (which indicates other useful principles of learning, including what might be done to prevent the student from forgetting what he has learned earlier in training). These guidelines will be used in making the selection of instructional features.

Now look at FORM 4 (Figure 29, page 108). FORM 4 provides the documentation of what instructional features are actually selected. You will see that a limited number of instructional features are included. The substeps involved in selecting and documenting instructional features are:

Substep 1: Complete Instructional Features Worksheet (This documents information which will be used in your selection of features.)

Substep 2: Select instructional features and complete FORM 4.

These substeps are further clarified below:

Substep 1. Complete Instructional Features Worksheet

The purpose of this worksheet is to record certain information about the learning environment which is used in your final selection of the instructional features. The information requested is critical in the selection process, so be careful and deliberate when completing the worksheet.

INSTRUCTIONAL FEATURES WORKSHEET

Trainer No _____

Initials _____

PRELIMINARY INFORMATION				MONITORING CONSIDERATIONS						FEEDBACK CONSIDERATIONS				STIMULUS CONSIDERATIONS		COMMENTS
1. REQUIREMENT NO		2. CRITERIA (Enter values for successful performance)	3. VARIABLES (Enter variables to be measured, one line for each variable)	4. WHO SENSES THE VARIABLES? (Enter for each variable)	5. WHO RECORDS THE VARIABLES? (Enter for each variable)	6. WHO SCORES? (Enter once for each criteria)	7. WHO REPORTS INFORMATION TO INSTRUCTOR?		8 WHO MONITORS THE SIMULATED SYSTEM (Enter per requirement)	9. WHO PRESENTS FEEDBACK MESSAGE? (Enter per requirement)			10. WHO CONTROLS NEXT ACTIVITY? (Enter per requirement)	11. WHO CONTROLS STIMULUS RATE? (Enter per requirement)	12 WHO CONTROLS SIGNAL TO NOISE RATIO? (Enter per requirement)	
a Behavioral Requirement No	b Taxonomic Code						a. Response (Enter for each variable)	b. Score (Enter for each score)		a Incorrect Response	b Score	c. Reason				

Figure 25. Instructional Features Worksheet

INSTRUCTIONAL FEATURES – FORM 4

Initials _____

Date _____

1. REF & TRAINER		MONITORING INSTRUCTIONAL FEATURES											FEEDBACK INSTRUCTIONAL FEATURES														STIMULUS INSTRUCTIONAL FEATURES				MISCELLANEOUS FEATURES					17. COMMENTS
a. Ref. No.	b. Trainer No.	2. SENSING, RECORDING, SCORING & REPORTING				3. SYSTEM MONITOR		4. REPORT DEVICE		5. STORAGE DEVICE	6. CRITERIA ADJUST		7. FEEDBACK CONTROL			8. MESSAGE ADJUST	9. FEEDBACK REPORT DEVICE	10. NEXT ACTIVITY			11. FREEZE				12. RATE CONTROL ADJUST		13. SIGNAL NOISE ADJUST		14. CUE ENHANCEMENT		15. MALFUNCTION INSERT		16. SIGN IN	
		a	b	Select		a	b	d	b		a	b	a	Select				a	b	c	a	b			a	b	a	b	a	b	a	b	a	b	
		Label	On-Off	c. Pre-Prog	d. Variable Input	a. Pre-Prog	b. Variable Input	Printer	CRT		a. Pre-Prog	b. Variable Input	a. On-Off	b. Pre-Prog	c. Variable Input			a. Change Branching	b. On-Off	c. Select	a. Inst. Activate	b. Override	Next Act. Cont. c. De-Act	d. Pre-Prog	a. Pre-Prog	b. Variable Input	a. Pre-Prog	b. Variable Input	a. Pre-Prog	b. Variable Input	a. System Parameter Set	b. Pre-Prog			

FORM 4

The Instructional Features Worksheet (Figure 28, page 107) must be filled out before FORM 4 is completed. The worksheet contains five major heading: Preliminary Information, Monitoring Considerations, Feedback Considerations, Stimulus Considerations, and a Comments Section. Instructions for completing the worksheet follow:

Preliminary Information

Column 1. Locate all the skills and knowledge (behavioral requirements) that are going to be taught on the trainer. These can be located by tracing the decisions in your completed FORM 3a to your FORM 2. Enter in Column 1 the reference numbers of the skills and knowledge found on FORM 2.

Column 2. In Column 2 enter the criteria for successful performance; that is, enter how well the student must display each behavior in order to be considered a successful performer (if known). For example, if the behavior is to "Perform a flight control surface check," enter what it would take for you to be satisfied that the student could display this behavior--such as perform it in 10 minutes or perform the steps with 100% accuracy (in the right sequence) in 8 minutes. In this latter example you would enter in Column 2--"100% accurate sequence within 8 minutes." Be sure to list any errors that are likely to occur that should be avoided.

Column 3. Enter what variables have to be measured to determine whether the criteria have been reached. In our example we need to measure elapsed time from beginning to end (since 8 minutes is a requirement), and the sequence of the steps as executed by the student (since accuracy is a concern). Where two variables are considered, list them in separate rows on the worksheet.

Columns 2 and 3 have now defined your learning objective for a particular skill or knowledge. You know what behavior needs to be displayed, you know what criteria must be reached and FORM 2 indicates the conditions under which the behavior must be displayed.

Monitoring Considerations

Now that you know what needs to be measured, you must decide who has control over the measurement process. Measuring student responses

(variables) is a complicated process. First the response has to be sensed, next the response must be recorded, and then the response must be scored (compared to the criteria). Finally, the response and/or score must be reported to the instructor. The instructor can perform all of these functions or the trainer or machine can perform them. The decision of who performs them influences the design of your trainer. To assist you in making these decisions follow the procedures below:

Column 4. Who senses the response; that is, who or what detects whether the student response has occurred? To make this decision use the flow chart in Figure 30 (page 111) as a guide. As you can see from looking at the flow chart, the decision "Who senses" is made by considering the nature of the response (how rapidly it occurs, and how easy it is to observe), and the time the instructor has available to observe the response. If the response cannot be easily observed, either because it occurs rapidly or because it is hidden from vision, then the trainer must sense the response. A "T" in the flow chart indicates the trainer is given this responsibility; an "I" indicates the instructor is given this responsibility.

Column 5. Who records the response? To make the decision follow the flow chart in Figure 31 (page 112). If the instructor is sensing the response, then the instructor must record the sensed response since the trainer will not even be aware the response occurred. However, if the trainer is sensing the response, either the instructor or the trainer could record the response that has been sensed. As you can see from the flow chart, this decision is made by determining if the sensed responses are occurring too rapidly to be recorded by the instructor. If they are, then the trainer must do the recording.

Column 6. Who scores the response? Who compares the responses to the criteria? To make the decision follow the flow chart in Figure 32 (page 113). If the trainer is recording the response, then you must decide if the trainer or the instructor is to score the response. The only way the trainer can score the response is if it has recorded all the variables that determine the score (other than the criteria). Thus, the decision of who scores is primarily based upon what indices are involved in calculating the score.

WHO SENSES THE RESPONSES?
COLUMN 4 OF INSTRUCTIONAL FEATURES WORKSHEET

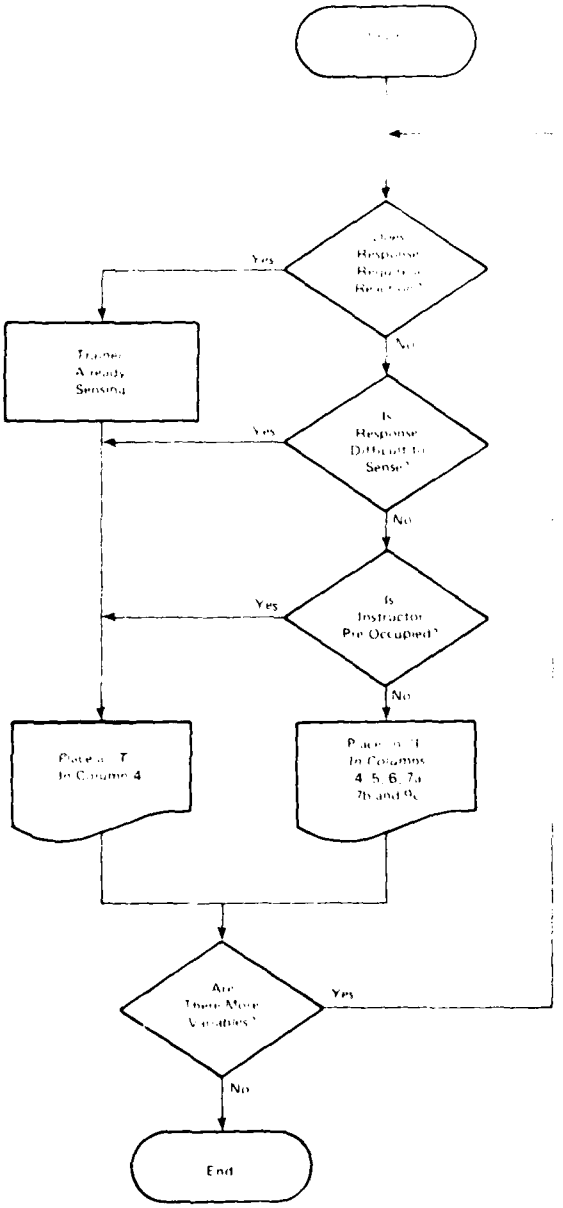
DECISION LOGIC	EXPLANATION
	Is the response difficult to sense by observation? Would it be difficult to see the student make the response? Does the response occur rapidly? If a measure is a time, does the time measure have to be extremely precise and accurate? Is the instructor doing something else so that he cannot sense the response? If yes, you need not look at the flow charts for Columns 5, 6, 7 and 10. Go to the flow chart for Column 8 after going through this flow chart for all other variables.

Figure 30. Who Senses the Responses? Column 4 of Instructional Features Worksheet

WHO RECORDS THE RESPONSE?
COLUMN 5 OF INSTRUCTIONAL FEATURES WORKSHEET

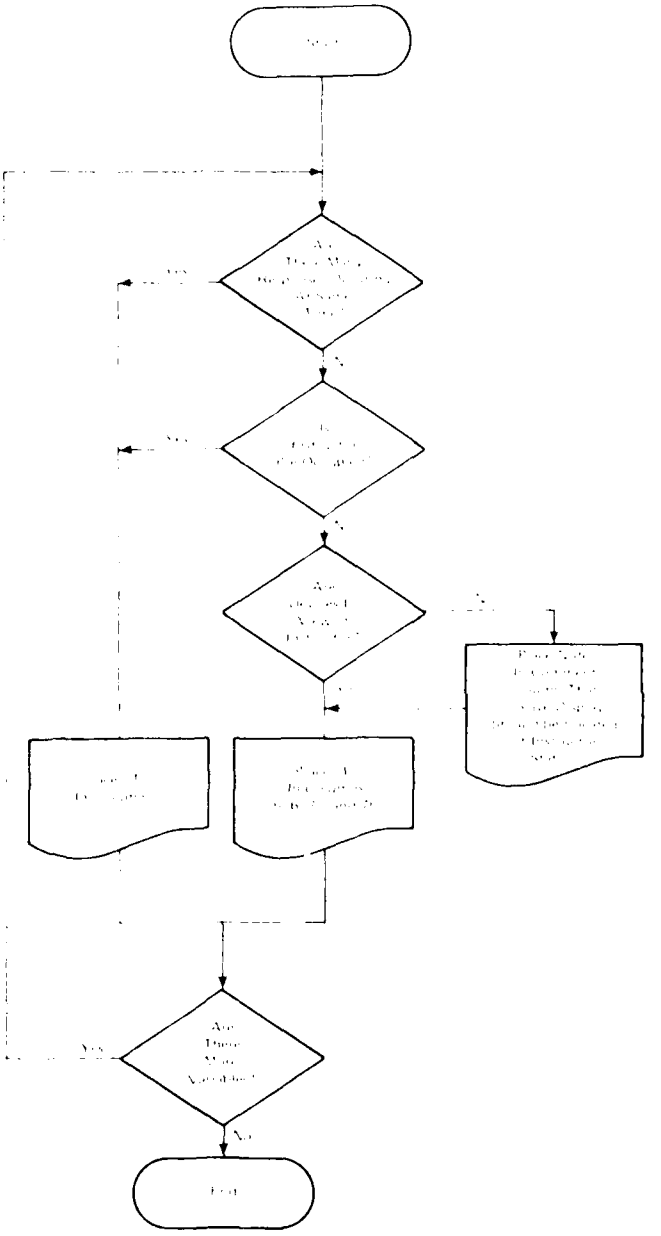
DECISION LOGIC	EXPLANATION
	

Figure 31. Who Records the Response? Column 5 of Instructional Features Worksheet

WHO S ORES THE RESPONSES?
COLUMN 6 INSTRUCTIONAL FEATURES WORKSHEET

DECISION LOGIC	EXPLANATION

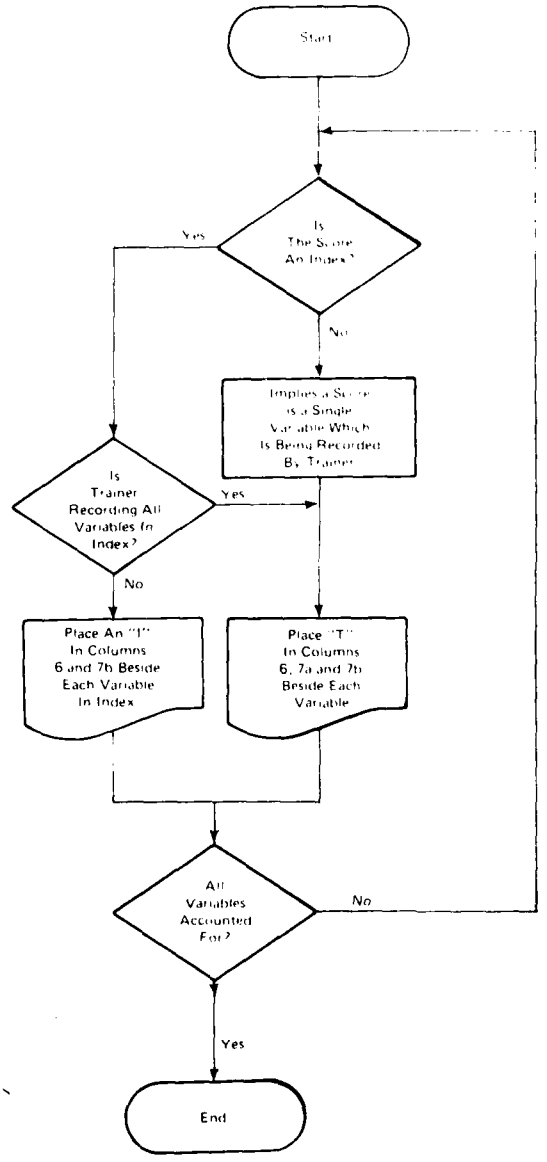


Figure 32. Who Scores the Responses? Column 6 of Instructional Features Worksheet

Column 7. Who reports the responses and scores? This column should already be completed by completing Columns 4, 5, and 6.

Column 8. Who monitors the system? To make this decision follow the flow chart in Figure 33 (page 115). This flow chart differs slightly from the previous ones. You must consider the entire objective when using this flow chart. The major question to ask yourself in making this decision is "How many system reactions are there to the student response?" If there are are several, then the trainer should monitor all of the system parameters that are affected. If there are only a few, then the instructor possibly can record the system parameters. In some cases you may elect to keep track of only certain parameters and not all of those that are affected. If this is your decision, record in the "comments" section those system parameters that have been selected.

Feedback Considerations

You have compiled all of the information required to make decisions concerning instructional features that control sensing, recording, scoring, reporting, and monitoring the status of the system. Now you can focus your attention on providing information to make augmented feedback consideration decisions (Columns 9 and 10 on the Instructional Features Worksheet).

It should be pointed out that instructional features are only concerned with augmented feedback and not the feedback that is directly received from the system being simulated. For example, when a dial is manipulated, it may cause a display to change. If the display on the trainer changes as a result of the manipulation of the dial, the machine or trainer is providing direct feedback to the student (that is, the new reading on the display provides feedback information to the student). This type of feedback was considered when you made the fidelity decision in Step 6. Typically, this is not the type of feedback that is of concern when talking about instructional features. Instructional features concern augmented feedback; that is, feedback which is not provided directly by the trainer as the result of the manipulation of a dial or control. Augmented feedback usually concerns a verbal or written communication to the student indicating the correctness of his response or the correctness of a set of responses. For example, an augmented feedback message might be a written communication on a CRT screen telling the student that his response was correct, and he should look at display XYZ to see the effect the manipulation had.

WHO MONITORS THE SYSTEM?
COLUMN 8 INSTRUCTIONAL FEATURES WORKSHEET

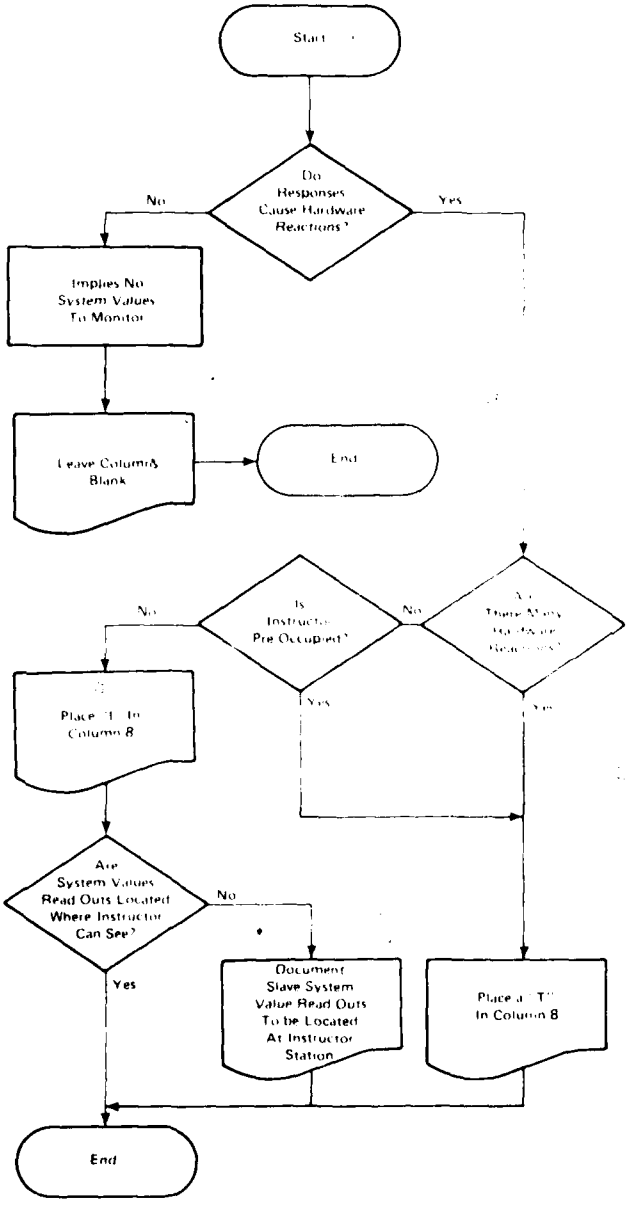
DECISION LOGIC	EXPLANATION
	Are student responses affecting the values within the system being simulated? If the student adjusts or sets a control or a display affected? If the student adjusts a control does the setting of the control make the system being simulated ready for another activity? Does an incorrect setting have potential to cause danger to personnel or hardware?
	Are there many hardware reactions? Are there so many that the instructor cannot keep track of them?
	If you have decided that the instructor is to monitor system parameters then you must make sure that system readouts are located at the instructor station. You may want to document this in the comments column.

Figure 33. Who Monitors the System? Column 8 of Instructional Features Worksheet

In addition, augmented feedback messages are often used to communicate to a student his score, after he has completed a problem set.

A column by column procedure is provided below for completing this section of the worksheet:

Column 9. Who presents the augmented feedback message to the students? To make the decision, follow the flow chart in Figure 34 (page 117). It should be noted that this feedback decision is related to who controls the scoring process as well as other measurement and monitoring functions. The primary question asked to make this decision is related to how much information the trainer already has concerning the student's performance. The content of the feedback message depends upon the behavior under consideration (each behavior, taxonomic code, or taxonomic element specifies the content of the augmented feedback message). Thus, to make this decision you must consult the Learning Guidelines (see Appendix B). If the trainer has all of the information, then it can provide the student with the augmented feedback message. If not, then the instructor must provide the student with the augmented feedback message. If the machine or trainer has only partial information then it can only provide a partial feedback message.

However, just because the trainer has all the information to provide the augmented feedback doesn't automatically dictate that the trainer should perform this function. A decision that the trainer should serve this function will lead you to select many expensive instructional features. Even if the trainer has all of the required information or content of the augmented feedback message, it is still possible for the instructor to provide the feedback message to the student. What you must consider in this situation is the augmented feedback schedule. If the augmented feedback message must be received by the student immediately then you must ask yourself, "Does the instructor have time to collect the entire content of the message and present it to the students?" If "Yes," then the instructor should provide the message; if "No," then the trainer should provide the message.

WHO PRESENTS THE FEEDBACK
COLUMN 9 INSTRUCTIONAL FEATURES WORKSHEET

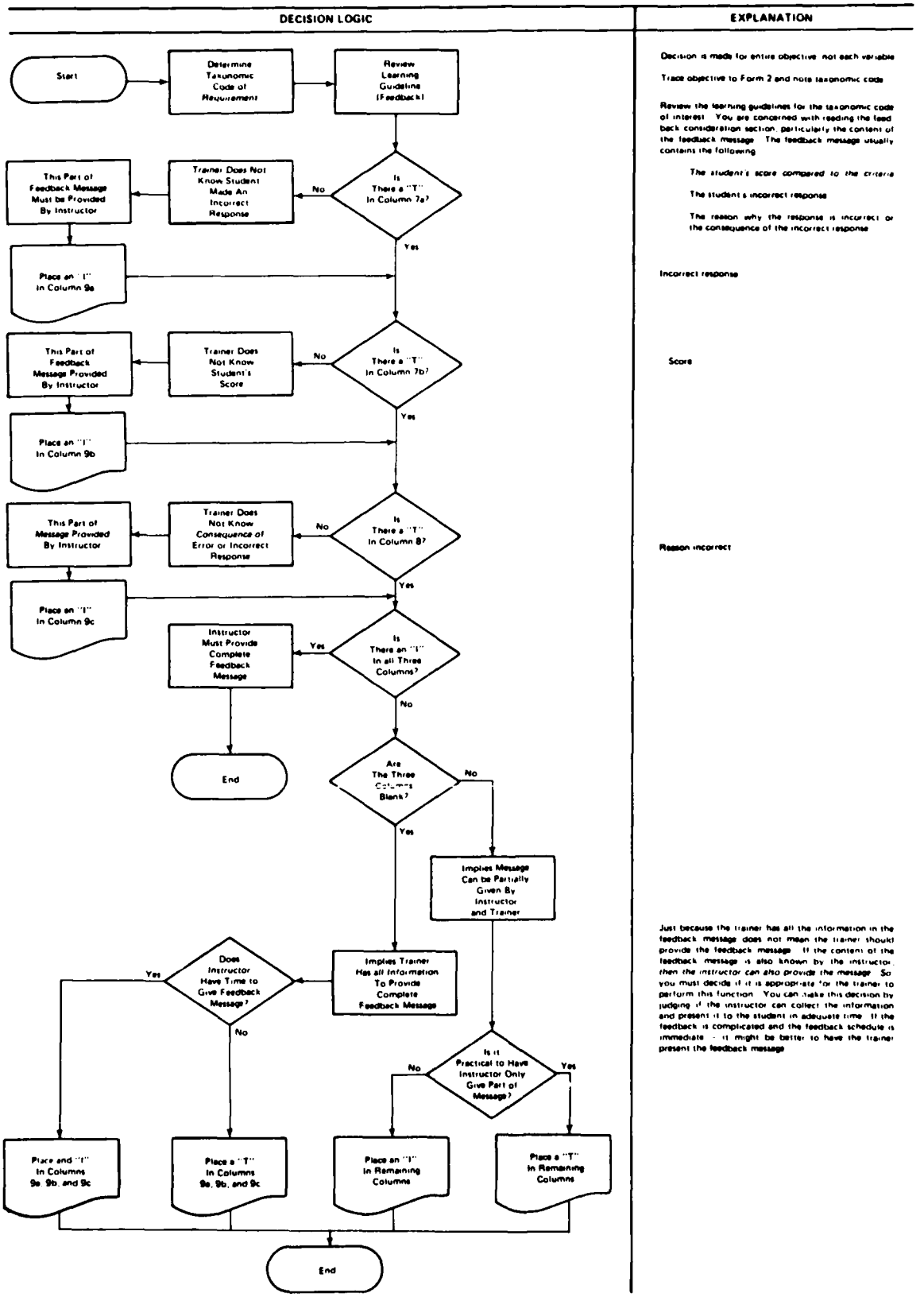


Figure 34. Who Presents the Feedback? Column 9 of Instructional Features Worksheet

Column 10. Who controls the next activity? Follow the flow chart in Figure 35 (page 119) to make this decision. You will notice that this decision is also influenced by what information the trainer may already have; thus who controls the next activity selected is discussed under the feedback section. The flow chart is self-explanatory.

Stimulus Considerations

You now have to decide who controls the rate of stimulus presentation and who controls the signal-to-noise ratio. Of these two you are probably less familiar with the signal-to-noise ratio. The signal-to-noise ratio refers to the ratio of relevant to irrelevant cues presented to the student. For example, suppose you are teaching students to detect a wave pattern on a video screen of some sort (a scope). On the job the pattern isn't clear (there is noise, interference). Your ultimate training objective might be to have the student recognize the pattern under the same conditions as occur on the job. However, in the early stages of learning it would be difficult for the students to recognize the pattern because of all the noise; thus, in the early stages of learning you might need to reduce the noise level. As the student's proficiency increases you would increase the noise level until it is identical to or greater than what actually appears on the job. In this situation, the signal-to-noise ratio needs to be controlled either by you or by the trainer.

Column 11. Who controls the stimulus presentation? To make this decision follow the flow chart in Figure 36 (page 120). This decision is primarily based upon how easy it is for the instructor to control the stimulus presentation rate. If it is difficult to control (for example, it requires many parameter adjustments or mechanical manipulations), then the trainer should control this aspect of the learning environment.

Column 12. Who controls the ratio of signal to noise? To make this decision follow the flow chart on Figure 37 (page 121). Again you will notice that the primary consideration involves how difficult and time consuming it would be for the instructor to control this aspect of the learning environment.

This concludes the directions for completing the Instructional Features Worksheet.

WHO CONTROLS NEXT ACTIVITY?
COLUMN 10 INSTRUCTIONAL FEATURES WORKSHEET

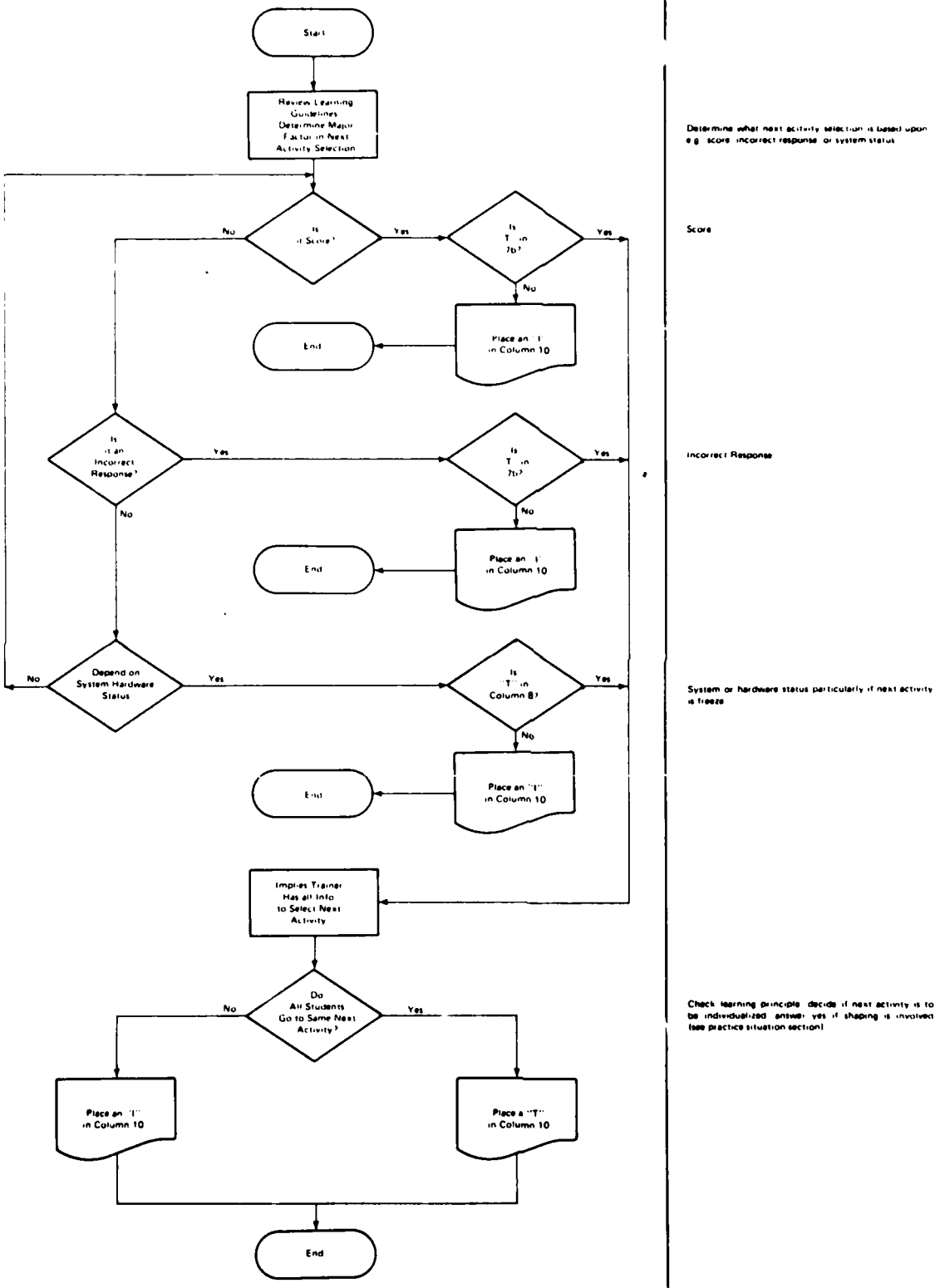


Figure 45. Who controls Next Activity? column 10 of Instructional Features Worksheet

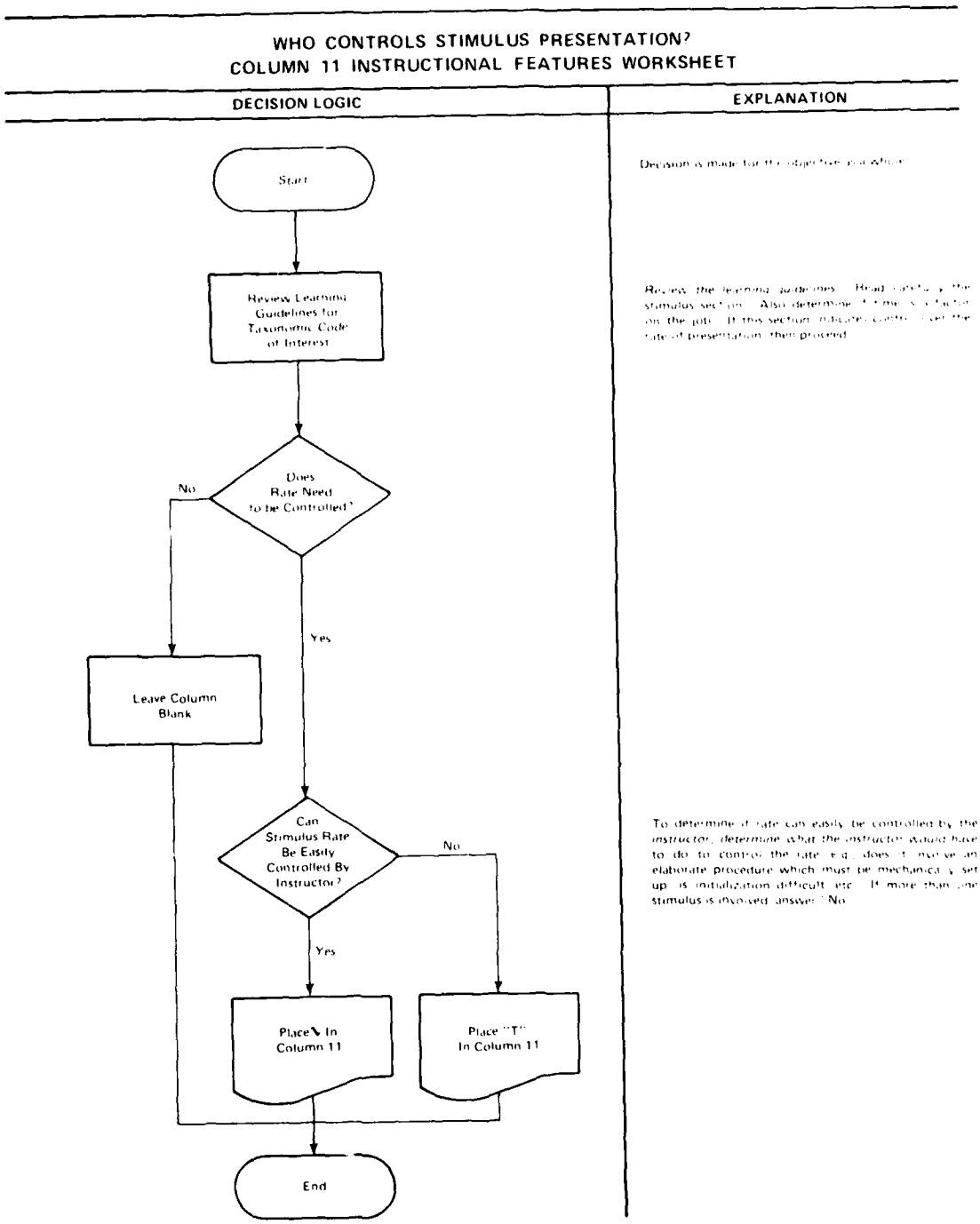


Figure 36. Who Controls Stimulus Presentation? Column 11 of Instructional Features Worksheet

WHO CONTROLS RATIO OF SIGNAL TO NOISE?
COLUMN 12 INSTRUCTIONAL FEATURES WORKSHEET

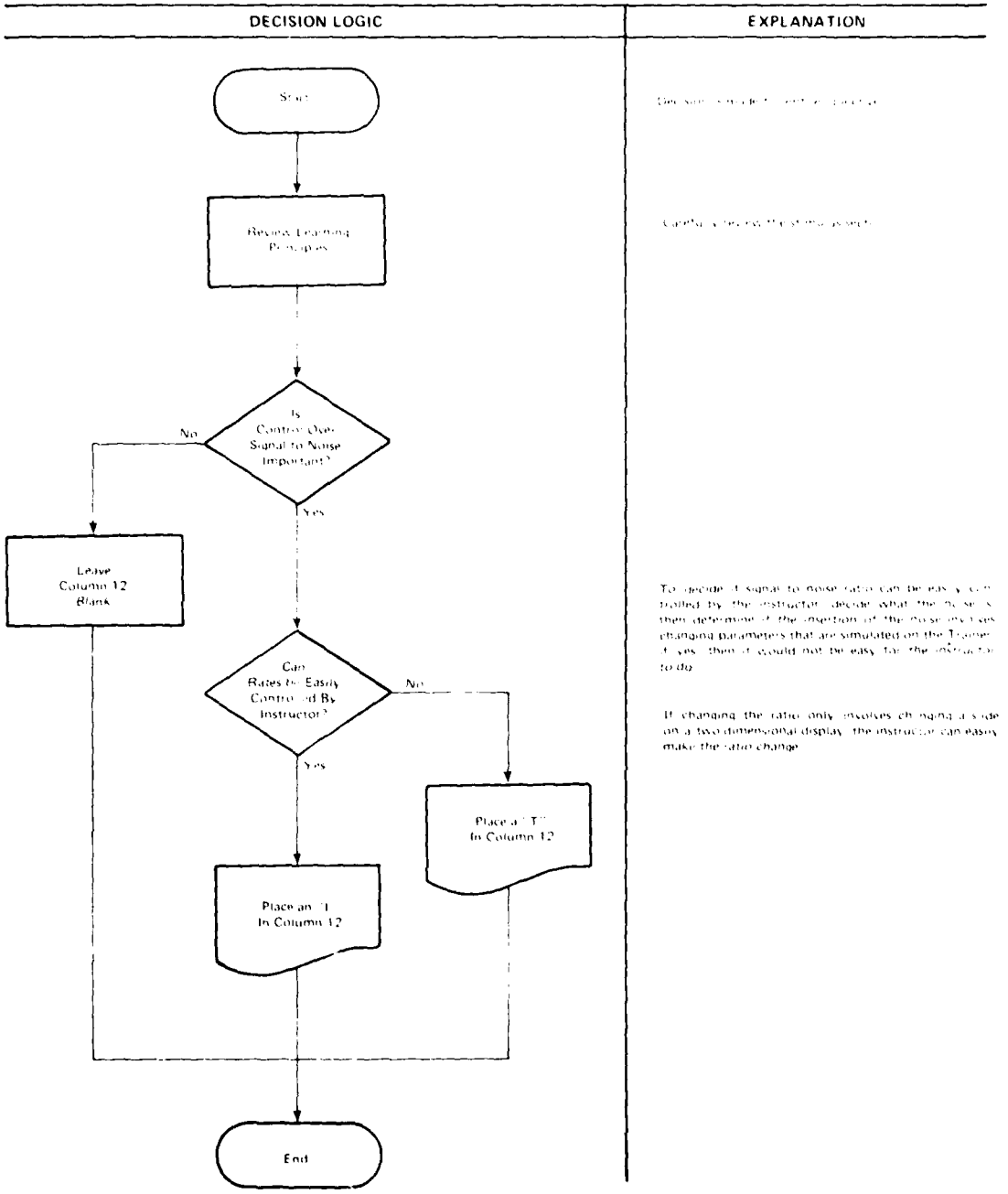


Figure 37. Who Controls Ratio of Signal to Noise? Column 12 of Instructional Features Worksheet

Substep 2. Selecting Instructional Features

You are now in a position to select the instructional features needed to accomplish the particular training requirement you are considering. If there is an "I" in every column of the Instructional Features Worksheet, then no instructional features will be needed since the instructor is controlling the learning environment completely and this substep can be bypassed. A list of the possible instructional features is found in Table 5 (pages 123 and 124). You should read the list carefully before continuing, especially the description of each instructional feature.

The procedures for selecting instructional features are described below. To make the selection you will need Form 4 Figure 29, (page 108) and the job aids or flow charts that guide you in making the selections. Each instructional feature has its own flow chart to be used when considering the selection of that instructional feature.

A. Complete the top part of FORM 4
The data requested is self-explanatory. Also enter the requirement number and trainer number, if there is more than one trainer.

B. Select Monitoring Instructional Features.
Review the Instructional Features Worksheet you completed in Substep 1, then follow the procedures below:

1. Start with the highest numbered column of Columns 4, 5, 6, and 7 in which a "T" appears. This becomes your primary monitoring instructional feature label. For example, if Column 5 has a "T" but not Column 6, then your primary label becomes "Recording." The reason you take the label of the highest column containing a "T" is to avoid having an instructional feature for each aspect of the measurement process. A control for the highest aspect will also control the lower aspects.

   Now go to the flow chart in Figure 38 (page 125). This flow chart helps you to determine if you need an on-off or select control feature. For example, if your primary label is "Recording," then the flow chart will help you decide if you need an on-off recording control or a select recording control. Primarily the decision between an on-off control

Table 5

List of Instructional Features

Features	Description
Response Features	
On-Off/Select Sensing	Allows the instructor to turn on-off the device(s) which sense the student responses or to select those variables which are sensed. Only appropriate if the trainer is sensing the responses. Control should be located on the instructor's station.
On-Off/Select Recording	Allows the instructor to turn on-off the device(s) which record the student responses or to select those responses or variables which are recorded. Only appropriate if the trainer is recording the responses or variables. Control should be located on the instructor's stations.
On-Off/Select Scoring	Allows the instructor to turn on-off the scoring capability of the trainer or to select those scores which are to be calculated. Only appropriate if the trainer is scoring the student responses; i.e., comparing the student response to the criterion. Control should be located on the instructor's station.
On-Off/Select Reporting	Allows the instructor to turn on-off the reporting capabilities of the trainer or to select what is and is not reported. Only appropriate if the trainer is doing the reporting. Control should be located on the instructor's station.
On-Off/Select Monitoring	Allows the instructor to turn on-off the system status report or to select what system variables are to be reported. Only appropriate if the trainer is monitoring the status of the system being simulated. Control should be located on the instructor's station.
Reporting Devices	
a. Printer b. CRT	Only appropriate if trainer is reporting to the instructor either or both the student's responses or score and/or system status; i.e, monitoring the status of the system. If the trainer is doing the reporting, the trainer needs some way to visually report the scores, responses, or system values. This can be accomplished either with a printer or a CRT screen. Either the printer or the CRT screen needs to be located at the instructor's station.
Storage Devices	
a. Hardcopy b. Electronic	Only appropriate if trainer is recording scoring and/or reporting student responses, scores, and system status values. In addition, storage is only important if feedback is based on performance over many sessions. Allows the instructor to store information concerning the student's performance. Two types of storage are possible, hardcopy e.g., from a printer), electronic storage (e.g., diskettes, magnetic tape, etc). If an electronic device is selected an electronic retrievel mechanism is needed.
Adjustable Criteria Control	Allows the instructor to change the performance values that a response is compared to. Only appropriate if trainer is scoring the student's responses. Used only when learning principles dictate a differnt criteria value for each stage of learning. Control should be located in the instructor's station.

Table 5 (Continued)

List of Instructional Features (Continued)

Features	Description
Augmented Feedback Features	
On-Off/Select Feedback	Allows instructor to turn on-off the mechanism that gives or reports the feedback to the student or allows the instructor to select when feedback should be given immediately or delayed. Only appropriate if trainer is presenting the feedback message to the student. Control should be located on the instructor's station.
Feedback Message Adjust	Allows the instructor to adjust or change the feedback message given to the student. Only appropriate if trainer is presenting the feedback message to the student. If selected need reporting device (see next feature).
Reporting Devices	
a. Printer b. CRT c. Other	Only appropriate if the trainer is presenting the feedback message to the student. If the feedback is under the trainer's control, the trainer needs a method or way to visually present the message to the student. This can be done using a printer, a CRT screen or some other device (e.g., slide projector, etc.). Reporting devices should be located at the student's station.
Next Activity Features	
On-Off/Select Next Activity	Allows the instructor to turn on-off the next activity pre-programmed for the student or allows the instructor to select the next activity from a list of pre-programmed next activities. Should be located at instructor's station.
On-Off Freeze	Allows the instructor to turn on-off the pre-programmed freeze instructions within the trainer or to freeze the trainer in a given state when a freeze is not pre-programmed. A freeze shall cause all displays, controls, indicators, etc. to remain fixed in their position at the moment of the freeze. Should be located at the instructor's station.
Stimulus Control Features	
Rate Control Adjust	Allows the instructor to set or adjust the rate of stimulus presentation. Only appropriate if the trainer is controlling the stimulus rate. Should be located at instructor's station.
Signal to Noise Adjust	Allows instructor set or adjust the ratio of signal to noise. Only appropriate if the trainer is controlling the signal to noise. Should be located at instructor's station.
Miscellaneous Features	
Cue Enhancement Control Options Off-On Select	Allows the instructor to control the highlighting of stimuli or responses. The control can take two forms--off-on and select. Off-on allows all cues to be on or off. Select allows the instructor to select what cues are to be functional. Control should be located at instructor's station.
Malfunction Insertion	Allows the instructor to insert malfunctions. Only appropriate for Problem Solving Behavior. Control located at instructor's station only.
System Parameter Control	Allows the instructor to pre-set system parameters which change the difficulty of the problem set. Note system parameter control can be used for malfunction insertion, if the number of parameters to be set is minimal.
Sign in	Allows the student to identify himself to the trainer--usually for record keeping purposes. Should be located at student's station. Only appropriate if trainer is keeping student score or recording student responses.

ON OFF/SELECT SENSING, ON OFF/SELECT RECORDING, ON OFF/SELECT SCORING, OR ON OFF/SELECT REPORTING

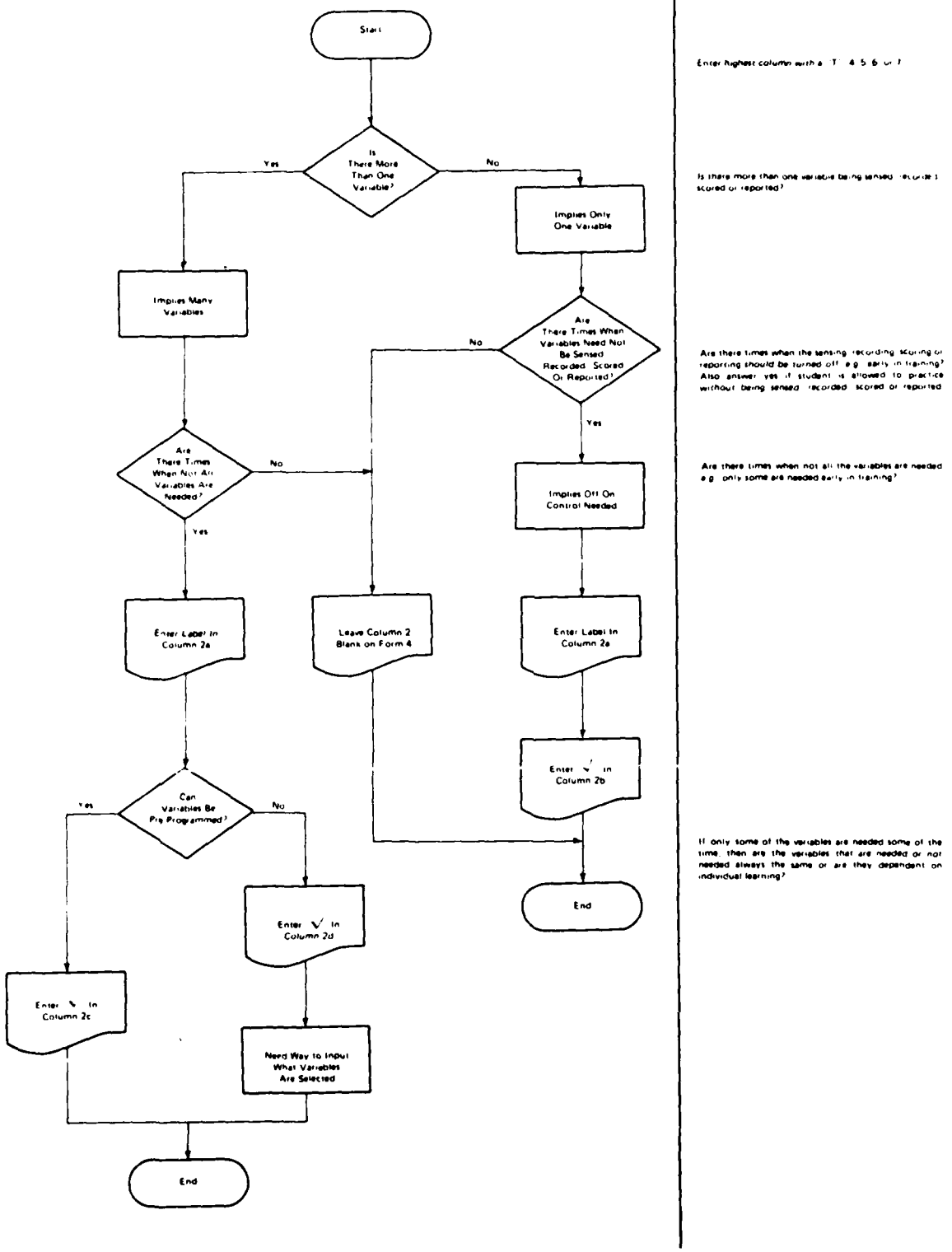


Figure 48. On Off/Select Sensing, On Off/Select Recording, on-Off/Select Scoring or On Off/Select Reporting

or a select type control is made by determining the influence of the stage of learning on the function.

It should be pointed out that there are typically two types of controls that can be placed on your trainer. The first type of control is strictly an on-off type (e.g., a control on the instructor station which supresses the recording mechanism). An on-off control, when "Off," means that the function will not be operative. The second type of control is a select control. Unlike an on-off control it is not an all or nothing control. For example, the select control allows the instructor to select what variable is to be recorded from a menu of possible variables. If there is no "T" in Columns 4, 5, 6, and 7, then go to "C" on page 131 ("Select Augmented Feedback Instructional Features").

2. If there is an "I" in Column 8 of the Instructional Features Worksheet then go to "3" below, otherwise go to the flow chart in Figure 39 (page 127) and determine whether you need a system monitoring instructional feature. This instructional feature allows you to print or report the system status. You will again be deciding if you need an on-off control or a select control, and again the basis for making the decision is the influence of the stage of learning on the particular behavior being analyzed.

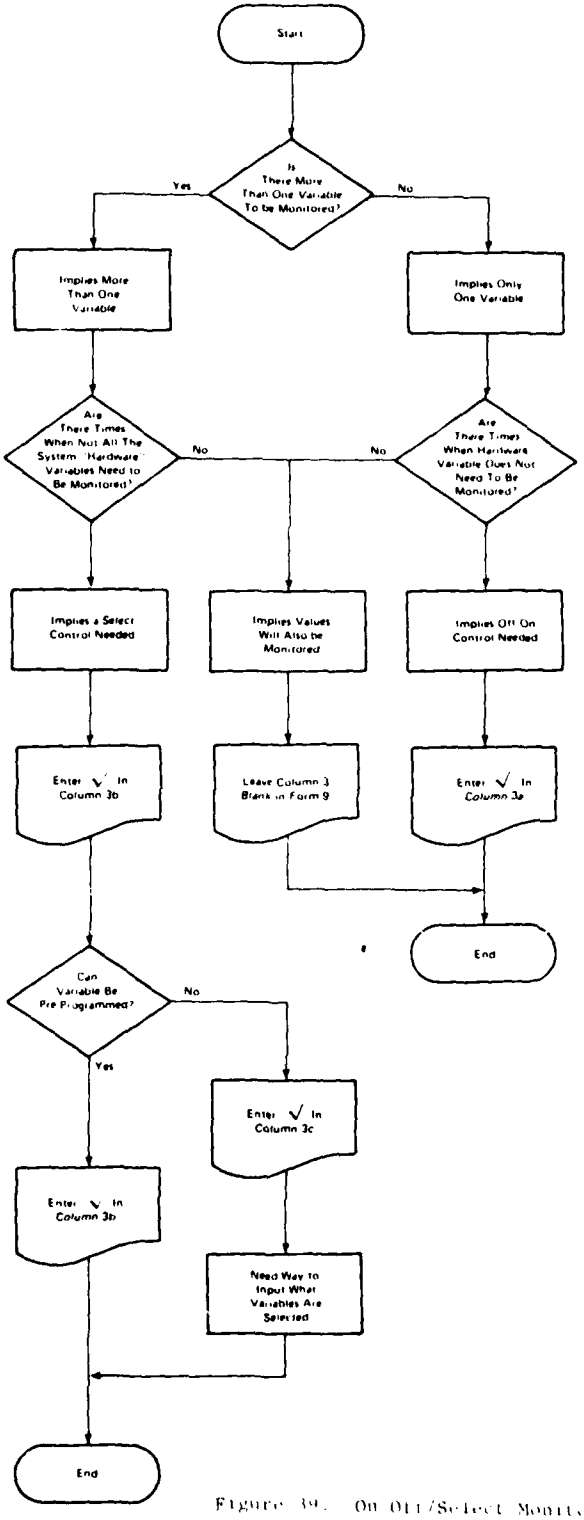
3. If there is a "T" in 7a or 7b of the Instructional Features Worksheet, you will need a device for reporting the responses or score to the instructor. To determine the type of reporting device you need use the flow chart in Figure 40 (page 128). You will be making a decision between a printer or a CRT.

4. Now you need to determine if a storage device is needed. To help you make this decision use the flow chart in Figure 41 (page 129). This flow chart not only helps you to determine if a storage device is needed, it also provides advice on what type of storage device might be required.

5. Now determine if you need a criteria adjust control. It is only appropriate if the trainer is scoring, that is if there is "T" in Column 7b of the Instructional Features Worksheet. (See the flow chart in Figure 42, page 130.)

ON-OFF/SELECT MONITORING

DECISION LOGIC	EXPLANATION



Assume there is a T in Column 8 [illegible] Features Worksheet

Is there more than one variable to be monitored and do the students response (and hardware features which are monitored?

It may not be necessary to monitor the variables all the time e.g. early in training

Can the variable that needs to be [illegible] pre programmed e.g. related to the stage of training

Figure 39. On-Off/Select Monitoring

REPORTING DEVICE

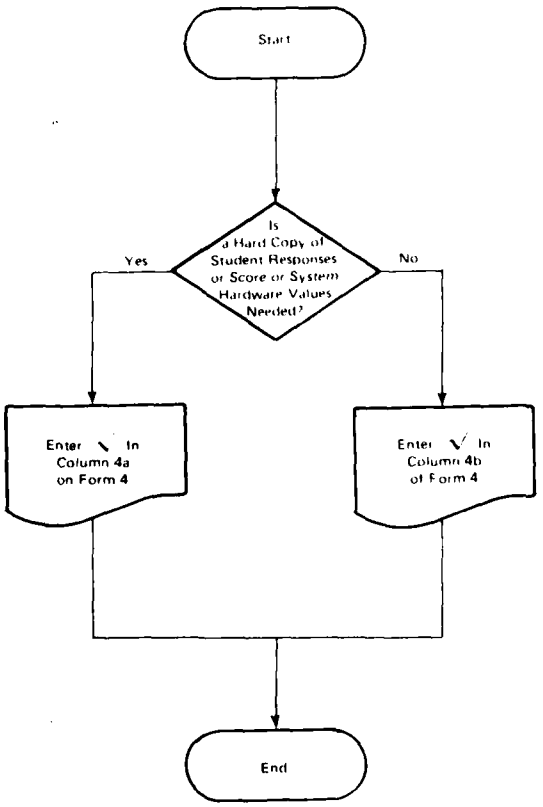
DECISION LOGIC	EXPLANATION
	Assume a "T" in Column 2a or 2b of Instructional Features Worksheet Do you need to keep a record in the file of the student responses, score or hardware values? Either printer or CRT can be used to input values if 2d or 3b of Form 4 is checked

Figure 40. Reporting Device

STORAGE DEVICE

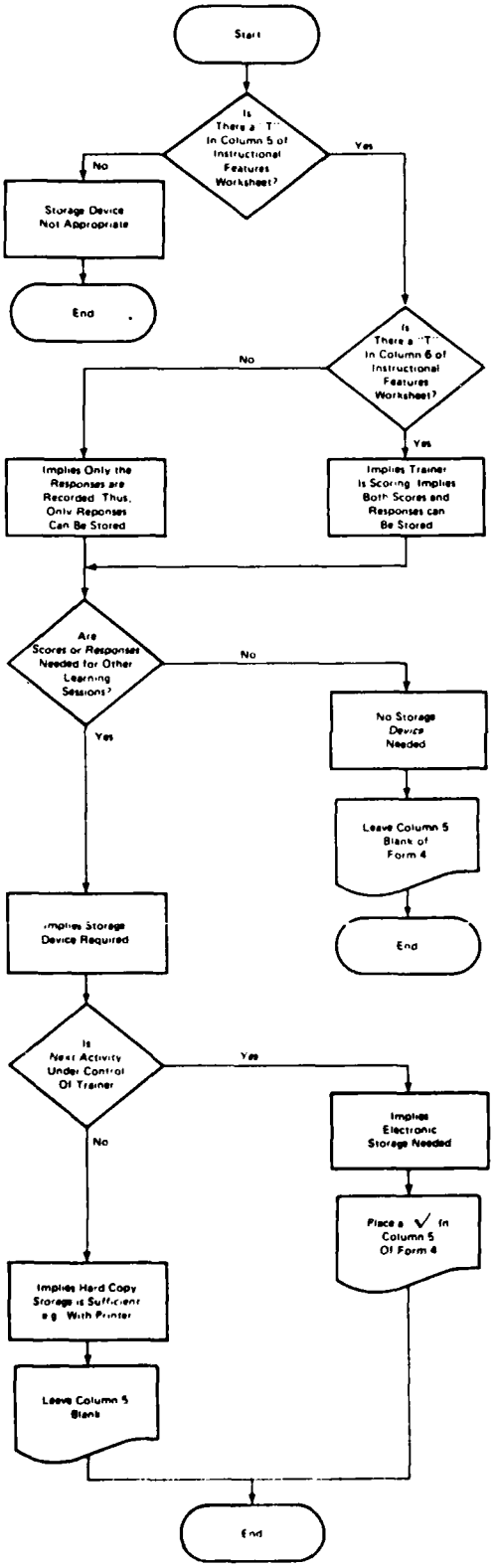
DECISION LOGIC	EXPLANATION
	This section of the flow chart determines what can be stored. It comes first because if nothing can be stored a storage device is not needed. Storage would only be a possibility if the responses or scores were needed in other sessions, e.g., if shaping is needed or if the next activity is remedial instruction or if the same error is repeated many times. Check to see if there is a "T" in Column 10 of the Instructional Features Worksheet. Is the next activity remedial instructional? Check to see if Column 4a of Form 4 is checked. If 4b is checked, then the instructor would have to transcribe from CRT to a form for storage.

Figure 41. Storage Device

CRITERIA ADJUST CONTROL

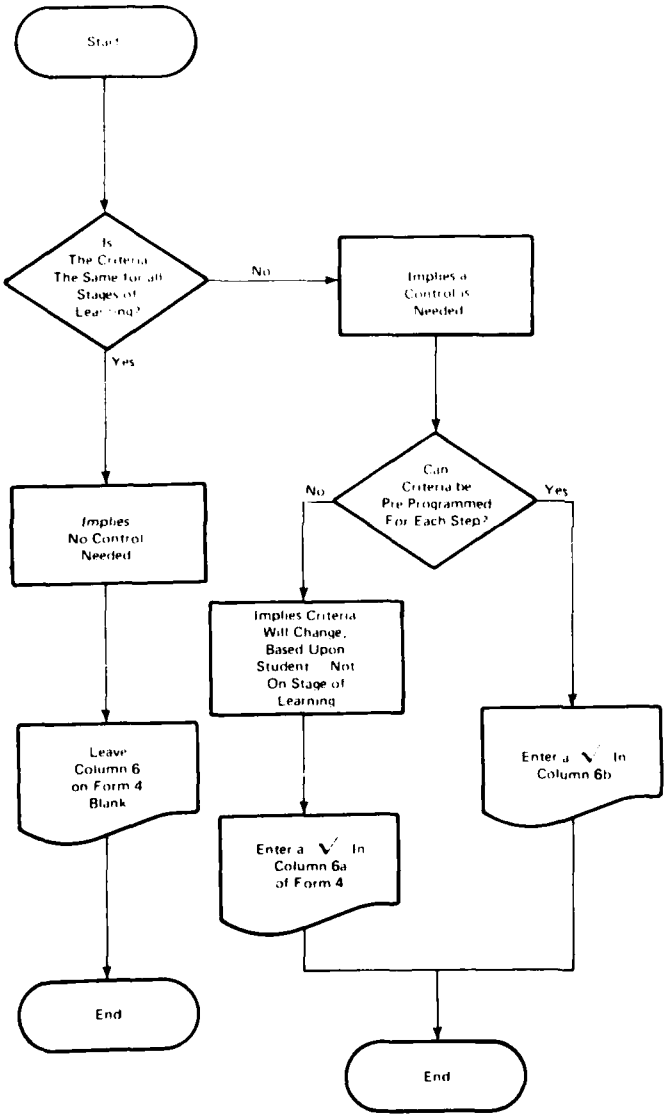
DECISION LOGIC	EXPLANATION
	Assumes trainer is scoring student responses (i.e., there is a "T" in Column 6 of the Instructional Features Worksheet). Review the learning principles. Determine if the same criteria is involved at each stage of learning. Typically the criteria of performance will be different at each stage. This is particularly true if shaping will be involved. Criteria level can be pre programmed. If criteria level is likely to change over the life cycle of the training, go back and answer "No" to the first question. If each stage has its own criteria level, then pre-programming is possible. If shaping of behavior is involved, answer "No". If criteria is to change and cannot be pre programmed, then a device is needed to enter the specific criteria level.

Figure 42. Criteria Adjust Control

C. Select Augmented Feedback Instructional Features.
To select these features follow the procedures below. You will be looking at such instructional features as on-off feedback message adjust, feedback reporting devices and freeze controls.

1. First you need to determine if a feedback control is needed. It is only appropriate if there is a "T" in Columns 9a, 9b, or 9c of the Instructional Features Worksheet, indicating the trainer is controlling the feedback message. To make the decision follow the flow chart in Figure 43 (page 132). You will see that the flow chart determines what type of feedback presentation control is needed, either an on-off or select control. The decision is based primarily upon the changing nature of the augmented feedback message over the various stages of learning.

2. Next, you must decide if you need a feedback message adjust control. There may be times when you want to adjust the feedback message that is given to the student. This instructional feature would be used only where the principle of shaping is involved. (See the Learning Guidelines, Appendix B, for the behavior of interest.) When shaping is involved you need to give the student an individualized message. Follow the flow chart in Figure 44 (page 133) to make the decision.

3. If the trainer is providing the feedback message to the student, then some device is needed for the student to receive this message. This message can be received through a printer, CRT, or some other device located at the student station. The type of device depends upon the cost. No flow chart is used for this decision. If there is a "T" in Columns 9a, 9b or 9c, then a device is needed, so enter a check in Column 9 of FORM 4.

4. If there is a check in Column 10 of the Instructional Features Worksheet, indicating that the trainer has control of the next activity, then you must determine if you want the instructor to override the next activity selected by the trainer. The options available are a "Halt" control and a next activity adjust. To make these decisions follow the flow chart in Figure 45 (page 134). Again you will notice that the decision is based primarily upon learning principles and practical considerations.

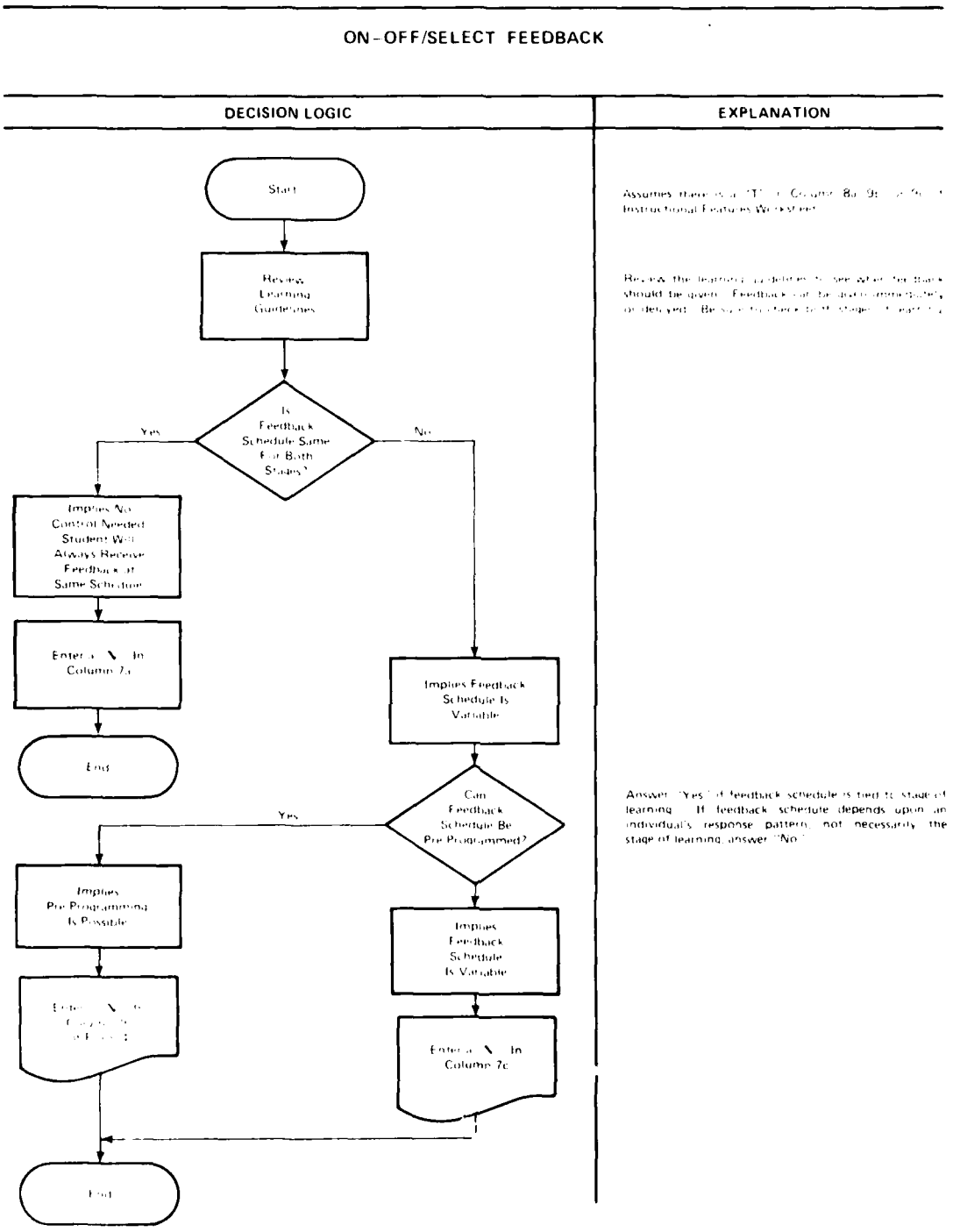


Figure 43. On-Off/Select Feedback

FEEDBACK MESSAGE ADJUST

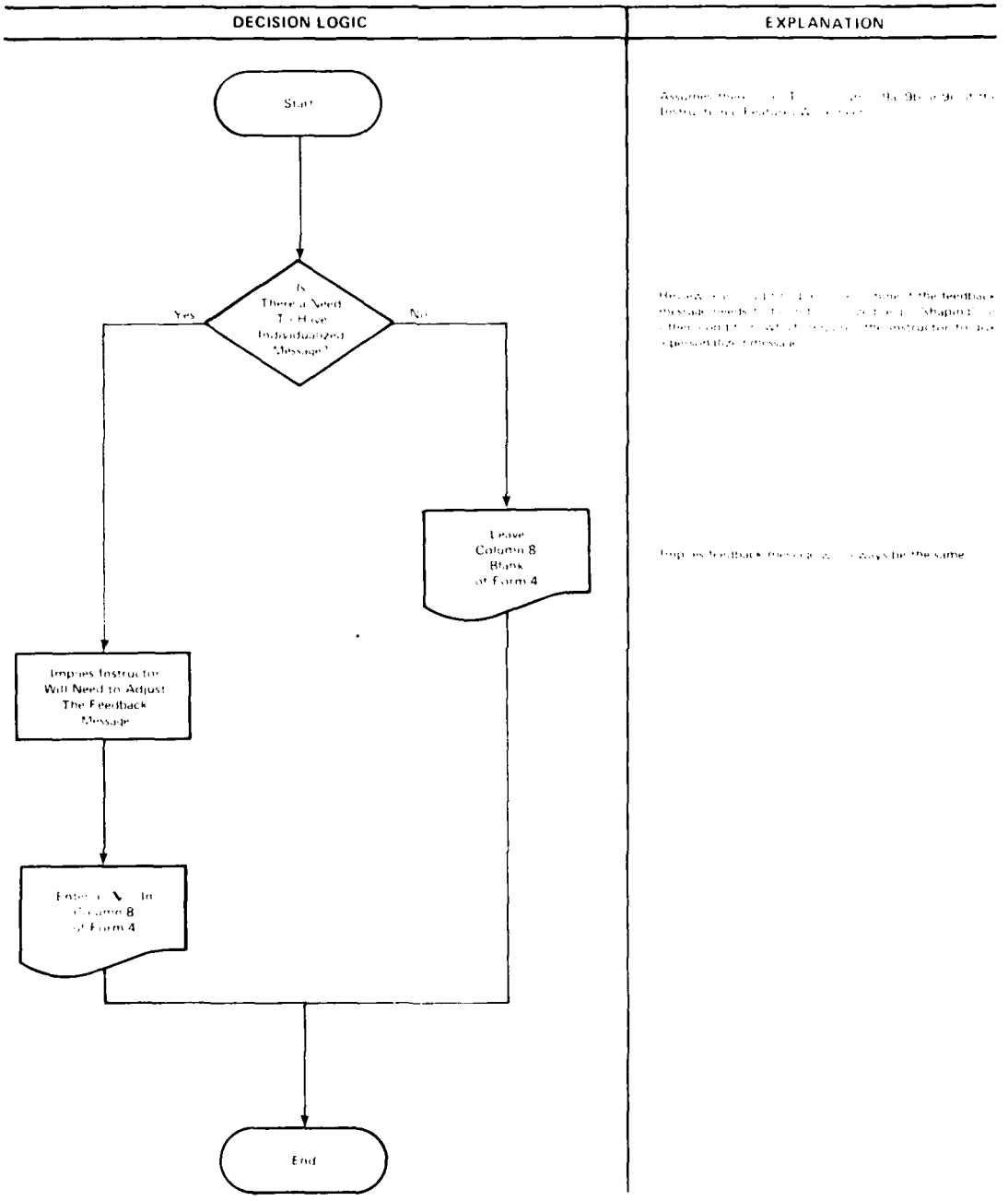


Figure 44. Feedback Message Adjust

ON–OFF SELECT NEXT ACTIVITY

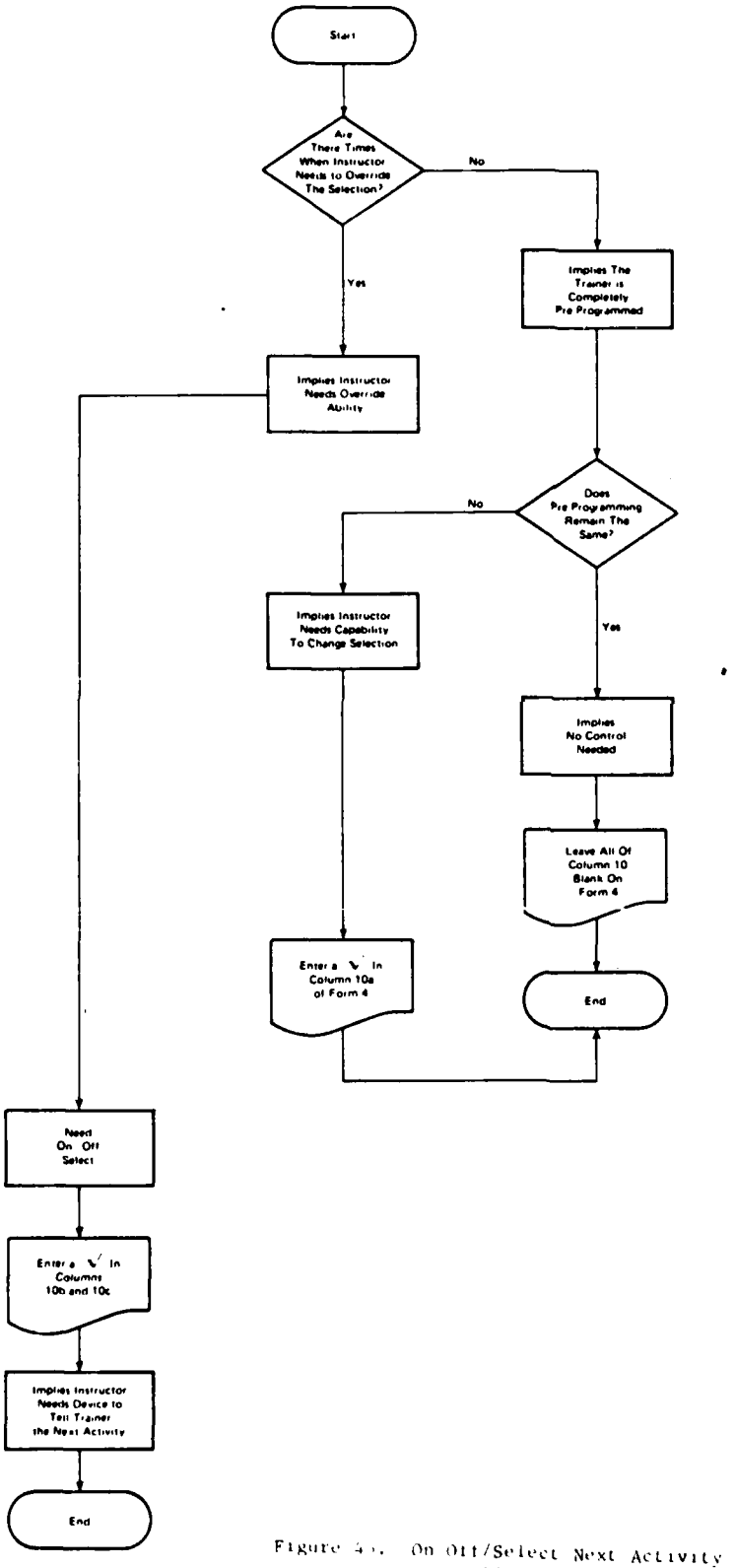
DECISION LOGIC	EXPLANATION
	Assumes there is a "T" in Column 10 of the Instructional Features Worksheet Are there times when the instructor needs to override the next activity selected by the trainer? A "Yes" also implies that the instructor needs a method to select the next activity Will the next activity selection remain the same through life cycle of trainer? Answer "Yes" unless there is a valid reason for "No" Implies instructor can turn off the next activity select, and needs a method to select the next activity. The on-off can be used as a half mechanism Can be a terminal, where next activities are selected

Figure 4-. On Off/Select Next Activity

5. Next you need to decide if a freeze control mechanism is needed. To make this decision read the flow chart in Figure 46 (page 136).

D. Select Stimulus Control Instructional Features.

1. If you have a "T" in Column 11 of the Instructional Features Worksheet, indicating that the trainer is going to control the rate of presentation, you need to decide what kind of control to use. To make the decision follow the flow chart in Figure 47 (page 137).

2. If you have a "T" in Column 12 of the Instructional Features Worksheet, indicating the trainer has control over the signal to noise ratio, you need to decide what type of control is needed. To make this decision follow the flow chart in Figure 48 (page 138).

E. Select Miscellaneous Instructional Features.
There are some miscellaneous instructional features you should consider using:

1. Cue enhancement control. This control allows the instructor to highlight stimuli or responses. To determine what kind of control is needed, follow the flow chart in Figure 49 (page 139).

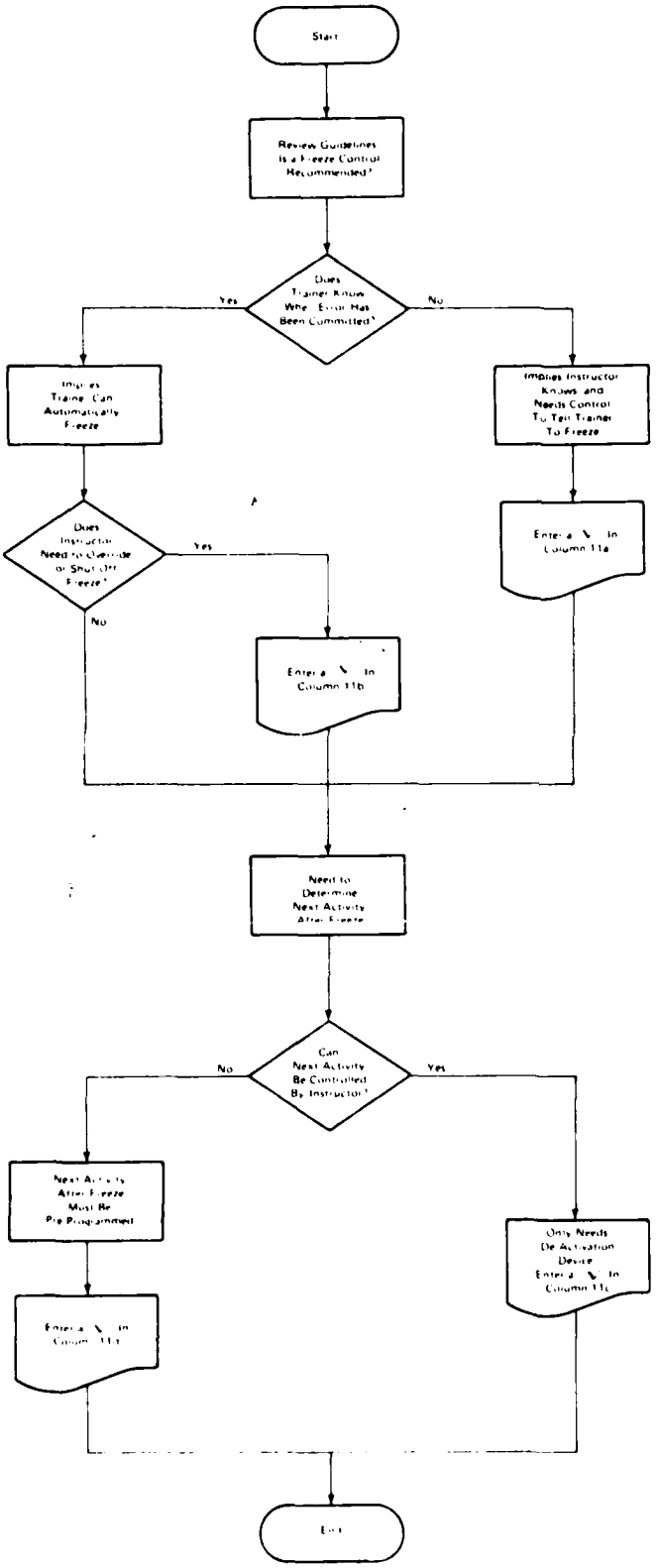
2. Malfunction insertion control. This control allows the instructor to insert malfunctions. It is only appropriate if the behavior is troubleshooting. To determine what kind of control is needed, follow the procedure in Figure 50 (page 140).

3. Sign-in control. This allows the student to identify himself to the trainer. Follow the flow chart in Figure 51 (page 141).

This completes the selection of the instructional features that are needed to achieve the behavioral requirement specified. You are to repeat the process for each requirement the trainee will achieve on the trainer.

After you have completed FORM 4 for all the requirements, you need to examine it carefully. You will find that some requirements need certain instructional features, while other requirements do not.

ON-OFF FREEZE

DECISION LOGIC	EXPLANATION
	A freeze control is possible regardless of how it monitoring the student on the system Does the trainer know when the student is about to make an error ... check to see if there are ... 9a, 9b, 9c ... If no, then answer NO Means instructor must monitor student and system The answer is usually "No". The purpose of the freeze control is to alert both the student and the system that something has occurred to structure a way ... want to disengage the freeze mechanism Need to decide the next activity after a freeze. Several options are available a. Restart problem from beginning b. Restart problem after errors are corrected ... correct errors and continue c. Select a new problem Whatever option is decided, a control is needed to start the next activity after the freeze Instructor can have control through next activity. Select "a new problem" is the next activity ... next activity is the beginning of the same problem ... If continuation is decided, answer "No"

RATE CONTROL ADJUST

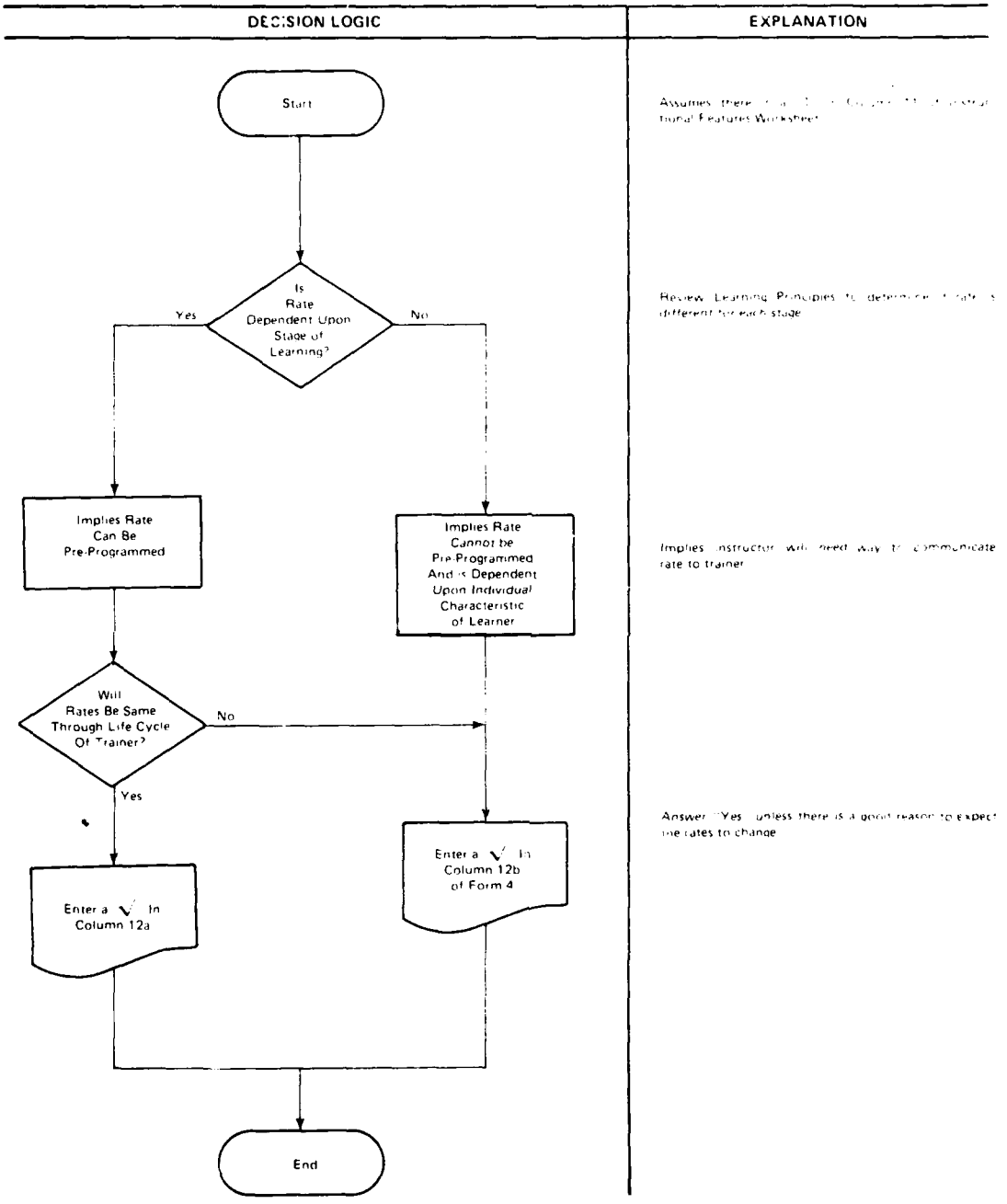


Figure 47. Rate Control Adjust

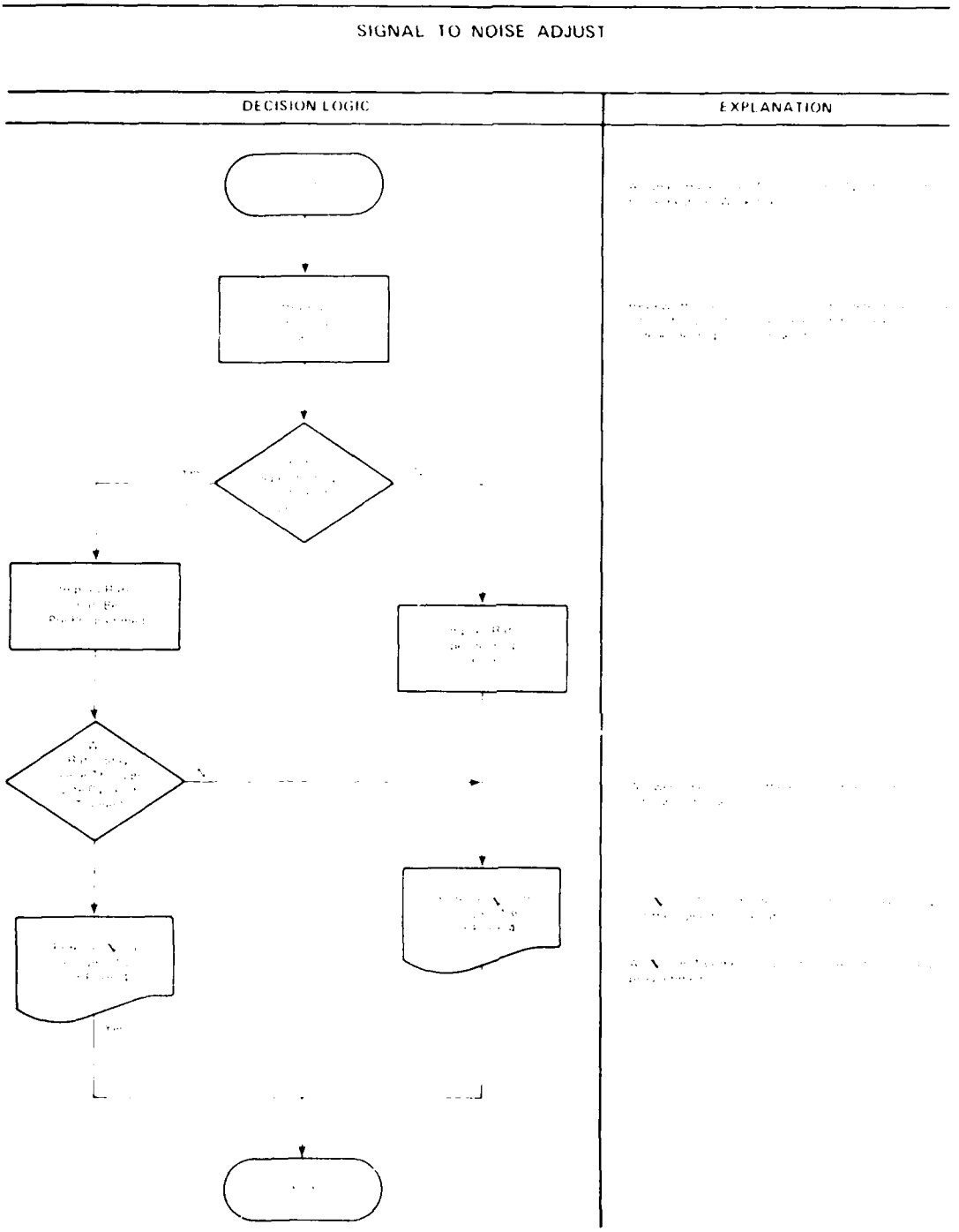


Figure 48. Signal to Noise Adjust

CUE ENHANCEMENT CONTROL

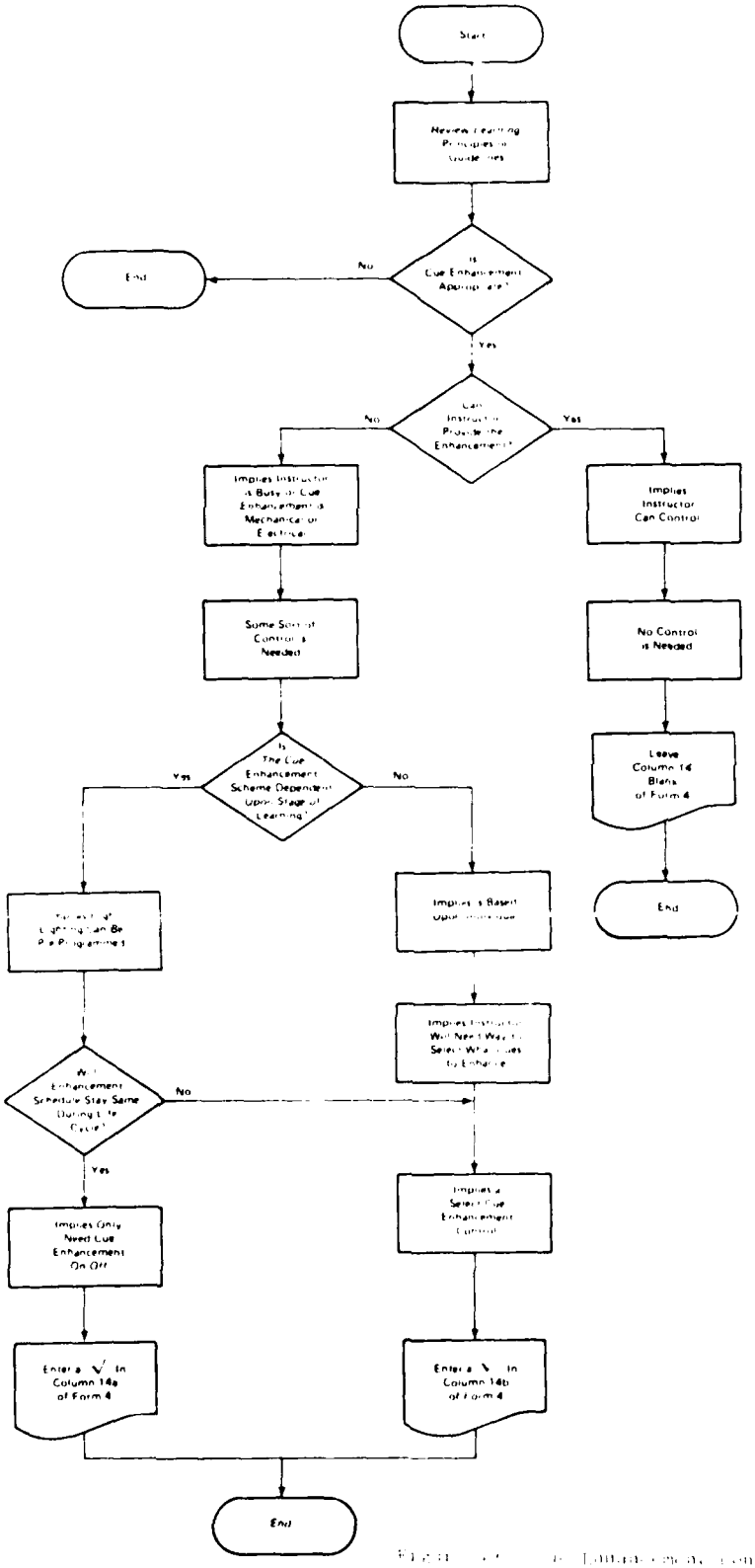


Figure [illegible] Cue Enhancement Control

MALFUNCTION INSERTION CONTROL SYSTEM PARAMETER CONTROL

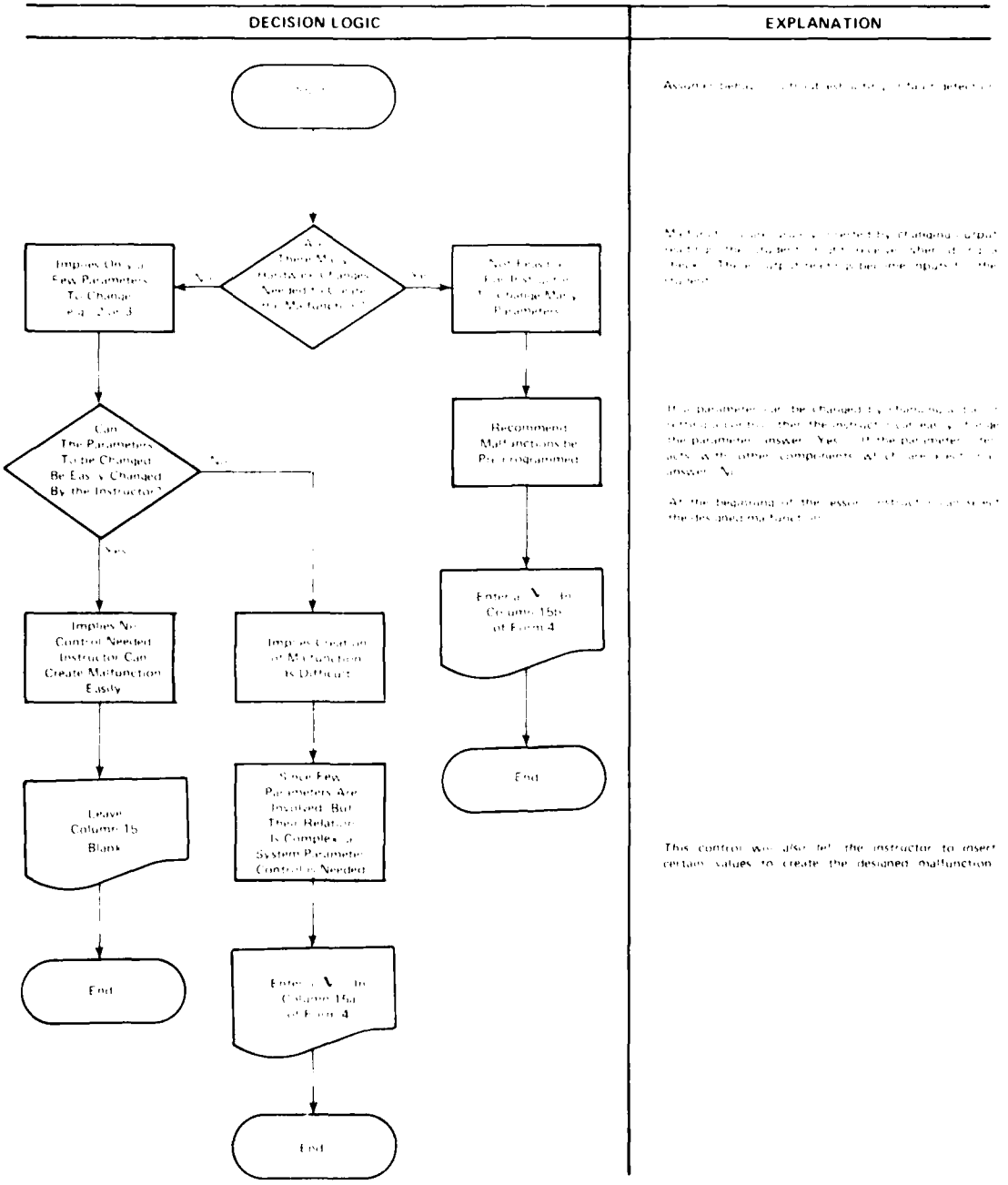


Figure 50. Malfunction Insertion Control System Parameter Control

SIGN-IN CONTROL

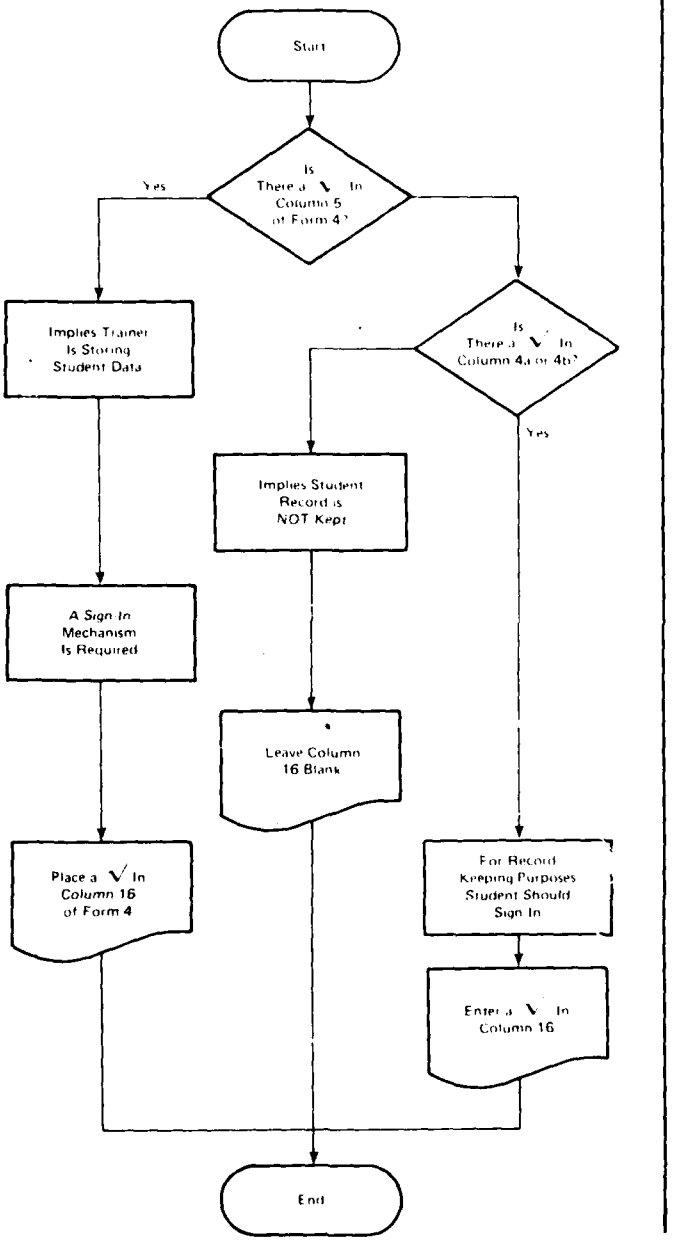
DECISION LOGIC	EXPLANATION
	Assumes trainer is doing the record keeping i.e. there is a "T" in Column 7a or 7b. Column 5 indicates if a storage device is needed. If a storage device is needed, it means the student responses are stored over trials. Thus, the trainer needs some way of identifying students.

Figure 51. Sign-In Control

After you have completed FORM 4 for all the requirements, you need to examine it carefully. You will find that some requirements need certain instructional features, while other requirements do not. Although at first glance this may seem odd, it should be realized that different taxonomic codes (behaviors) are taught differently (meaning that different instructional features might be needed).

Collapsing Control Features

All the instructional features where pre-programming is indicated specify that control is dictated by the stage of learning. Instead of having many controls, you may want one control that sets the stage of learning (early or late). The control might then monitor what is scored, the criteria the student's response is compared to, the feedback message that is received, the next activity selected, the freeze conditions, and the rate of stimulus presentation. Thus, separate controls for each of these might not be needed. Examine FORM 4 carefully and try to collapse the controls to a few; that is, make one control serve many functions. To help you collapse, look at Table 6 (page 143). It indicates what might be done by a single control. If you collapse controls, be sure to specify the control as well as the function the control will serve. This can be done at the bottom of FORM 4.

Additional and Remedial Instruction

There are times when your trainer might present additional or remedial instruction to the student. For example, if your next activity involves remedial instruction, or if before using the trainer the student must be presented with basic knowledge, then these features might be built into your trainer. The procedures described above are only used for those skills and knowledge (behavioral requirements) where fidelity decisions were made. It is conceivable that other skills and knowledge might be taught on the trainer. That is, in Step 4 you separated your skills and knowledge statements into two groups, those where hardware was needed and those where non-hardware media was indicated. In Step 5, you made an initial try at sequencing the skills and knowledge. This resulted in changing the media class of some of the skills and knowledge. In Step 6, you made fidelity decisions for those skills and knowledge to be acquired on the hardware. Steps 6 and 7 resulted in a defined set of characteristics that your trainer should have. Now that you have a better idea of what your trainer is going to look like, you should review your preliminary media choices (Step 4).

Table 6

Collapsing Strategy

Control	Possible Functions
Stage of learning control (late, middle, early)	Combine all instructional features on Form 4 which involve pre-programming. Column 2c: Reporting select Column 3a: System monitoring Column 6a: Criteria adjust Column 7b: Feedback control Column 11a: Next activity control Column 12a: Rate control adjust Column 13a: Signal noise adjust Column 14a: Cue enhancement adjust These instructional features are pre-programmed for the stage of learning.
Terminal (at instructor station)	A terminal will allow a mechanism to input conditions and make certain adjustments. Consider combining all the functions below to the terminal: Column 2d: Report select Column 3b: System monitor Column 4a: Printer Column 6b: Criteria adjust Column 7c: Feedback control Column 8: Feedback message adjust Column 10a: Next activity Column 10c: Next activity Column 11a: Activate freeze Column 11c: Deactivate freeze Column 12b: Rate control adjust Column 13b: Signal noise adjust Column 14b: Cue enhancement Column 15a: System parameter input These instructional features all require a way to set or adjust in potential software or programs.

It is possible that some of the skills and knowledge that were identified as being taught on non-hardware media can be acquired on the trainer. For example, location of parts and components was probably identified as being taught using visual media (such as slides). However, now that you have the trainer designed you might find it more reasonable to use the trainer to achieve this objective or behavioral requirement.

Similarly you may find it reasonable to build into the trainer some of the skills and knowledge that were originally sequenced to be taught before the trainer was actually to be used by the students. To do this you should recheck your preliminary sequencing (Step 5), then decide if some of the skills and knowledge that are prerequisite to using the trainer can and should be incorporated into instruction on the trainer. Your decisions should be based upon such considerations as:

A. Can these skills and knowledge be incorporated without interfering with the flow of students using the trainer?

B. Is the media class identified for those skills and knowledge compatible with the design of the trainer? For example, if computer assisted instruction is identified, does the trainer use a computer? If "No," can the media class be changed?

A "No" to the above questions indicates that perhaps the acquisition of those skills and knowledge should not be built into the trainer.

If you decide that some of the skills and knowledge can be built into the trainer, then include them, but be sure you make a note at the bottom of FORM 3a for the additional skills and knowledge. In addition, you should list the media that must be built into the trainer. For example, if slides are going to be used, then you need to specify that the trainer needs to be equipped with a slide projector. Be sure that you include all other media that is going to be attached to the trainer.

Example

An example has been developed to illustrate the selection of instructional features. A FORM 2 has been prepared (see Figure 52, page 145) which identifies one training requirement needing hardware. Let's assume that other training requirements indicate hardware is also needed. Also assume that fidelity decisions have been made concerning

1 TASK/SUBTASK NUMBER	2 TASK/SUBTASK TITLE	3. INITIALS	4 DATE	5 PAGE OF
XXXX 03	REMOVE & REPLACE POWER ASSEMBLY	JAS	10-20-80	1 1

6 WUC	7 AFSC	8 ADDITIONAL INFORMATION SOURCES AND DATES
XXX	XXXX	REPORT FW3401, PAGE 172

9 REQ	10 REF	11 BEHAVIORAL REQUIREMENT	12. SKILLS/KNOWLEDGE TRAINING REQUIREMENT						13 TAX CODE	14. TRAINING DEVICE REQUIRED							15 ALT MEDIA	16 METHOD	17 COMMENTS
			a. New	b. Condition	c. Criteria	d. Negative Transfer	e. Tool/Equip	f. None		a. Difficult	b. Condition	c. Criteria	d. Hardware Cues	e. Tool/Equip	f. Hi Conseq.	g. Time/Freq			
1	-2	Loosen front panel mounting screws.						✓											
2	-2	Pull front panel out and to one side.						✓											
3	-2	Disconnect power cable (force connection apart with screwdriver taking care not to cause cable breakage).			✓				RMN			✓			✓				

Form 2

Figure 3.2 FORM 2 Example

these particular skills and knowledge, and that these requirements are to be acquired using a sophisticated trainer. This is, assume instructional features must be selected for this requirement.

The Instructional Features Worksheet containing this requirement has been completed and appears in Figure 53 (page 147). It should be noted that the instructor is sensing, recording scoring, and reporting. These decisions were made because the variables involved were easy to observe and the instructor had the time available to inspect the students' performance for broken cables. Column 8 was left blank because there were no system parameters to monitor. Column 9a, 9b, and 9c have an "I" indicating that the instructor (since he is scoring and reporting) will be responsible for providing feedback to the student. Since the instructor is providing the feedback message, it is impossible for the trainer to control the next activity, and an "I" was entered in Column 10. A review of the Learning Principles Guidelines indicated that Columns 11 and 12 did not apply.

Because all of the columns on the Instructional Features Worksheet contain either an "I" or are blank, no instructional features are needed for this requirement. That is, this requirement would not appear on a FORM 4. Had a "T" been present in some of the columns, then a FORM 4 would have been prepared using the flow charts discussed above.

INSTRUCTIONAL FEATURES WORKSHEET

Trainer No. A

Initials JAS

PRELIMINARY INFORMATION				MONITORING CONSIDERATIONS						FEEDBACK CONSIDERATIONS				STIMULUS CONSIDERATIONS		COMMENTS
1. REQUIREMENT NO.		2. CRITERIA (Enter values for successful performance)	3. VARIABLES (Enter variables to be measured, one line for each variable)	4. WHO SENSES THE VARIABLES? (Enter for each variable)	5. WHO RECORDS THE VARIABLES? (Enter for each variable)	6. WHO SCORES? (Enter once for each criteria)	7. WHO REPORTS INFORMATION TO INSTRUCTOR?		8. WHO MONITORS THE STIMULATED SYSTEM (Enter per requirement)	9. WHO PRESENTS FEEDBACK MESSAGE? (Enter per requirement)			10. WHO CONTROLS NEXT ACTIVITY? (Enter per requirement)	11. WHO CONTROLS STIMULUS RATE? (Enter per requirement)	12 WHO CONTROLS SIGNAL TO NOISE RATIO? (Enter per requirement)	
a. Behavioral Requirement No	b. Taxonomic Code						a. Response (Enter for each variable)	b. Score (Enter for each score)		a. Incorrect Response	b. Score	c. Reason				
2-1-3	RMV	disconnect without damaging cable	accuracy-inspect cable for breakage	I	I	I	I	I		I	I	I	I			

Figure 53. Instructional Features Worksheet Example

- ☐ STEP 1 Identify System Maintenance Requirements
- ☐ STEP 2 Identify Characteristics of the Target Population
- ☐ STEP 3 Determine Training Requirements
- ☐ STEP 4 Determine the Type of Technical Training Materials Required
- ☐ STEP 5 Sequence Skills and Knowledge (Utilization Plan)
- ☐ STEP 6 Identify Fidelity and Simulated Features
- ☐ STEP 7 Select Instructional Features
- ■ STEP 8 Prepare ISD Specification
- ☐ STEP 9 Identify Method
- ☐ STEP 10 Prepare Course Control Documents (CCD'S)
- ☐ STEP 11 Prepare Instructional Materials and Tests
- ☐ STEP 12 Validate Instruction
- ☐ STEP 13/14 Conduct Training and Evaluate Training

STEP 8. PREPARE ISD SPECIFICATION

Once you have completed Steps 6 and 7, you are ready to prepare the ISD-Derived Training Equipment Design. This document is a model for recording the training equipment design. The model is written in a military specification format. Your application of the model will be used by SIMSPO to prepare the specification that goes to vendors. SIMSPO will need certain information from you, the instructional system designer, to adequately prepare the SPO specification. The model will strive to communicate this information to SIMSPO personnel. That is, the model is used as a vehicle for ISD personnel to communicate to SIMSPO the results of ISD analysis.

Also at this time you will have to begin preparations for the Training Requirements Recommendation Review Meeting (TRRRM). Follow the procedures described in the 3306th Procedural Handbook (page 103), but include the forms you have compiled here instead of those listed in the Handbook.

Most of the information required in the ISD-derived specification appears on the FORMs you have been preparing by following this procedure. In fact, the FORMs themselves can be inserted into the specification. However, there are some other pieces of information not contained on the FORMs which need to be communicated. All of the additional information has already been given considerable thought; now you need to specify it in writing.

The model specification is bound in a separate document titled Maintenance Training Simulator Design and Acquisition: ISD-Derived Training Equipment Design. Accompanying the model is an appendix or Handbook which provides instructions for applying the model in specific situations. Since the model is discussed in detail in another document, only a brief overview is provided here.

Brief Description of Model

The model specification for documenting the training equipment design resulting from the ISD analysis is divided into five major

paragraphs: Training Objectives, Training Application, Simulation Characteristics, Instructional Features, and Trainer Configuration. Each of these is discussed briefly below.

Training Objectives. Within the major paragraph the following information is requested:

1. Characteristics of the target population (e.g., AFSC of incoming students, instances of negative transfer - as identified by FORMs 2, any assumptions made about the target population).

2. List of the training objectives to be achieved using the proposed trainer.

3. List of the tasks (and part tasks) to be acquired and/or practiced on the trainer.

4. List of malfunctions to be simulated and isolated and/or corrected by the student.

Training Application. This paragraph was designed to communicate a scenario of how the trainer will be used to achieve the specified training objectives, to achieve and/or practice the specified tasks and to isolate and/or correct the specified malfunctions. This paragraph also provides an opportunity to specify (as much as is known at the time of using the model) the training enviornment. For example, within this paragraph any job aids the student will be permitted to use while practicing on the trainer are specified. Also specified are any equipment design characteristics which affect the learning environment (e.g., the design requires the classroom to have a special arrangement or configuration).

Simulation Characteristics. Specified in this paragraph are the physical and functional characteristics of the components to be represented on the trainer. Each component is described in as much detail as possible to assure that the trainer will work in the desired manner to achieve the specified objectives.

Instructional Features. Within this major paragraph the required instructional features are listed and described. Also described is the proposed instructor station and the proposed student station.

Trainer Configuration. Specified in this major paragraph are the internal and external interfaces required on the proposed maintenance trainer.

Concluding Remarks

This step may seem somewhat out of order as it is not the typical procedural step that has been accomplished up to this point. However, this step is important. Because of the acquisition cycle, it is necessary for you to complete the statement of maintenance training equipment requirements as soon as possible. That is, as soon as you have enough information to complete the specification, the specification should be completed. You may not be able to supply all the information requested in the specification, or it may be necessary to supply information in less detail than requested in the specification. However, you should supply what is known and the level of detail that is known at this point in the process.

- ☐ STEP 1 Identify System Maintenance Requirements
- ☐ STEP 2 Identify Characteristics of the Target Population
- ☐ STEP 3 Determine Training Requirements
- ☐ STEP 4 Determine the Type of Technical Training Materials Required
- ☐ STEP 5 Sequence Skills and Knowledge (Utilization Plan)
- ☐ STEP 6 Identify Fidelity and Simulated Features
- ☐ STEP 7 Select Instructional Features
- ☐ STEP 8 Prepare ISD Specification
- ■ STEP 9 Identify Method
- ☐ STEP 10 Prepare Course Control Documents (CCD'S)
- ☐ STEP 11 Prepare Instructional Materials and Tests
- ☐ STEP 12 Validate Instruction
- ☐ STEP 13/14 Conduct Training and Evaluate Training

STEP 9. IDENTIFY METHOD

Now that you have completed the model for documenting the training equipment design, only a few steps remain in the process. This step concerns selecting or identifying the method of instruction for each behavioral requirement.

The procedure for identifying instructional method is accomplished as Step 9 in the 3306th Procedural Handbook (pages 104 to 106) and in Volume IV, Chapter 4 of AFP 50-58. While AFP 50-58 provides a useful summary of characteristics of instructional methods (pages 4-9 to 4-17), the procedure below selects the method of instruction in a manner different from either AFP 50-58 or the 3306th Procedural Handbook. In these two procedures method is selected after media. In the procedures presented in this document the media class has already been selected in Step 4. The media class was selected at that time so you could identify which skills and knowledge should be acquired on hardware.

Figure 54 (page 154) is a media/method matrix. The instructional method is determined according to the media class previously chosen to teach a particular skill or knowledge. Refer to the media entry under Column 15 of FORM 2. Locate that media class on the left-hand side of the matrix, then read across to determine the suitability ratings of the various instructional methods for presenting material in that medium. Where possible, select a method that is highly suitable for the medium you have chosen. When choosing among alternatives, consider relative cost, class size, and instructor and facility availability. Refer also to the 3306th Procedural Handbook, page 89, and use the selection grid presented there to discriminate among methods for suitability in teaching various skills and knowledge. Recall that the taxonomic code for each training requirement is found in Column 13 of FORM 2. Enter your final choice for instructional method in Column 16 on FORM 2.

Once you have completed this step, you are ready to complete the remaining steps in the ISD process. As you will discover, the remaining steps in the process are the same as appear in the 3306th Procedural Handbook and AFP 50-58.

MEDIA/METHOD MATRIX

MEDIA	METHOD: SELF PACED OR PROGRAMMED INSTRUCTION	TRADITIONAL LECTURE	GUIDED DISCUSSION	DEMONSTRATION	PERFORMANCE BY STUDENT	PEER/PEDAL INSTRUCTION
AUDIO (AUD)	M	H	L	M	L	M
PRINTED MATERIALS (PRT)	H	H	M	L	L	H
STILL VISUAL (SVS)	L	M	L	M	L	M
SOUND STILL VISUAL (SST)	L	M	L	H	M	H
SOUND MOVING VISUAL (SMO)	H	H	M	H	M	M
COMPUTER ASSISTED INSTRUCTION (CAI)	H	L	L	L	M	H
HARDWARE (HRD)	M	L	L	H	H	M

SUITABILITY
H - High
M - Moderate
L - Low

Figure 54. Media/Method Matrix

- ☐ STEP 1 Identify System Maintenance Requirements
- ☐ STEP 2 Identify Characteristics of the Target Population
- ☐ STEP 3 Determine Training Requirements
- ☐ STEP 4 Determine the Type of Technical Training Materials Required
- ☐ STEP 5 Sequence Skills and Knowledge (Utilization Plan)
- ☐ STEP 6 Identify Fidelity and Simulated Features
- ☐ STEP 7 Select Instructional Features
- ☐ STEP 8 Prepare ISD Specification
- ☐ STEP 9 Identify Method
- ■ STEP 10 Prepare Course Control Documents (CCD'S)
- ■ STEP 11 Prepare Instructional Materials and Tests
- ■ STEP 12 Validate Instruction
- ■ STEP 13/14 Conduct Training and Evaluate Training

STEP 10. PREPARE COURSE CONTROL DOCUMENTS (CCDs)

To complete this step you should follow the procedures in the 3306th Procedural Handbook (pages 107 to 108). The 3306th Procedural Handbook recommends using 3306th TES FORM 2 (TEST) as the primary source for preparing the course control documents. When following the procedures presented here you should use FORM 2 as your primary source. In addition, for those behavioral objectives involving the use of equipment or hardware, you will find FORMs 3 and 4, the Instructional Features Worksheet, and the Preliminary Sequencing Worksheet useful (see Step 5 in this document).

STEP 11. PREPARE INSTRUCTIONAL MATERIALS AND TESTS

The description of this step is well documented in AFP 50-58 (Volume II) and the 3306th Procedural Handbook (pages 108 to 110), so it will not be discussed here.

STEP 12. VALIDATE INSTRUCTION

Step 12 is not altered by the procedures recommended in this document. You can follow the procedures in AFP 50-58 (Volume IV) or in the 3306th Procedural Handbook (page 110).

STEP 13 AND STEP 14. CONDUCT TRAINING AND EVALUATE TRAINING

These steps remain unchanged by the procedure presented in this document. A comprehensive discussion of these steps can be found in the 3306th Procedural Handbook (Chapter 2, pages 110 to 111) or in AFP 50-58 (Volume V).

GLOSSARY

GLOSSARY

Associating

Naming or responding to a specific input. The person associates a response with a specific input only. The response may be vocal, subvocal, written, or motor.

Classifying

Recognizing patterns; seeing the similarity among a class of objects or events which call for a common response; generalizing.

Continuous Movement

Perceptual-motor skills involving continuous pursuit of a target or keeping dials at a certain reading. Involves smooth eye-hand coordination and control. Compensatory movements based on feedback from displays. May involve scanning of complex displays to determine current status of system and to predict the evolving state of the system.

Cue Enhancement

Highlighting a stimulus by increasing the intensity of the stimulus or decreasing the noise surrounding the stimulus.

Discriminating

Being able to distinguish between inputs. Making different responses to the different members of a particular class.

Exercise

An experience the student is exposed to in order to attain a training objective and/or to acquire and/or practice the performance of a specific task or part-task. An exercise is composed of the presentation of the stimuli, the set of responses made by the student, the feedback given to the student concerning the correctness of his response(s), and the determination of the next activity the student is to be exposed to after making a response or a set of responses. An exercise is to be envisioned as a unit of instruction.

Feedback

Information given to the student concerning the correctness of response(s) to particular stimuli. There are two kinds of feed back: feedback which the student receives from the simulated equipment itself (e.g., the reaction of a display as a control is manipulated) and augmented feedback. Augmented feedback is the feedback given to the student by the instructor or by the instructional features built into the trainer. Augmented feedback usually consists of a message which contains a summary of the student's response(s), the correctness of the student's response(s), the consequences of any incorrect response(s), and the reason why a particular response was incorrect.

Fidelity

The degree to which components, parts, LRUs, SRUs, etc. (which are being simulated) are physically and functionally like the actual components, parts, LRUs, SRUs, etc.

Initialization

The activities and functions to be performed by the instructor to make the trainer ready for use by the student.

Instructional Features

Are devices or mechanisms on the trainer which control critical aspects of the learning environment, such as presentation of the stimuli, recording and scoring of responses, presentation of augmented feedback messages, and selection of the next activity the student is to be engaged in. The following are instructional features:

a. On-Off/Select Sensing. A control on the trainer which allows the instructor to turn on or off the devices or mechanisms which sense the student's response(s) or to select only those responses which are to be sensed for a given student exercise. A response that is sensed by the trainer is not necessarily recorded by the trainer.

b. On-Off/Select Recording. A control on the trainer which allows the instructor to turn on or off the devices or mechanisms which record the response(s), or to select only those student responses which are to be recorded for a given exercise. A response that is recorded by the trainer is not necessarily scored by the trainer. All responses recorded by the trainer, however, must be sensed by the trainer.

c. On-Off/Select Scoring. A control on the trainer which allows the instructor to turn on or off the devices or mechanisms which score the recorded responses or to select only those recorded responses to be scored for a given exercise.

d. On-Off/Select/Reporting. A control on the trainer which allows the instructor to turn on or off the devices or mechanisms which report student response(s) or score(s), or allows the instructor to select what response(s) or score(s) are to be reported.

e. On-Off/Select Monitoring. A control on the trainer which allows the instructor to turn on or off the devices or mechanisms which monitor the status of the controls and/or displays of the system or subsystem being simulated, or to select which controls and/or displays are to be monitored for a given exercise. All system displays and/or controls, which are monitored by the trainer, are sensed, recorded, and reported by the trainer.

f. Reporting Devices. A device used to report student responses and/or scores and/or the status of the system being simulated. Reporting devices are only used if the trainer is reporting responses, scores, or the system status to the instructor. Reporting devices as used in this specification are either computer controlled printers or CRT (video) screens.

g. Storage Devices. A device used to store student responses, scores, or the status of the system being simulated for future retrieval (e.g., diagnostic purposes or for planning future next activities for the student). Storage devices, as used in this specification are either hardcopy (e.g., printouts which are filed in a convenient manner) or electronic devices (e.g., diskettes, magnetic tape, hard disks, etc.).

h. Adjustable Criteria Control. A control on the trainer which allows the instructor to adjust (change or modify) the value that student responses are compared to during scoring. This control is only appropriate if the trainer is automatically scoring student responses.

i. On-Off/Select Feedback Control. A control on the trainer which allows the instructor to turn on or off the devices or mechanisms that provide the student with augmented feedback messages, or to select the time or schedule of the

augmented feedback message given to the student during a given exercise.

j. Feedback Message Adjust. A control or device which allows the instructor to adjust (change or modify) the augmented feedback message that is given to the student during a given exercise.

k. Rate Adjust Control. A control on the trainer which allows the instructor to adjust (change or modify) the rate at which stimuli are presented to the student during a given exercise.

l. Signal-to-Noise Adjust. A control on the trainer which allows the instructor to adjust (change or modify) the ratio of signal-to-noise for a given exercise.

m. Cue Enhancement Control. A control on the trainer which allows the instructor to highlight (magnify, intensify, or otherwise make more noticeable) a stimulus or response for a given exercise. The control can be an on-off control, where all stimuli or responses are highlighted, or a select control, where the instructor can select which stimulus or response is to be highlighted for a given exercise.

n. Malfunction Insertion. A control on the trainer which allows the instructor to select a malfunction which has been pre-programmed into the trainer.

o. System Parameter Control. A control on the trainer which allows the instructor to pre-set (before the exercise begins) a system parameter value or allows the instructor the input system parameter values during the exercise. The control can be used to make operational a malfunction condition, providing the system parameter being altered signifies a malfunction condition.

p. On-Off/Select Next Activity. A control on the trainer which allows the instructor to turn on or off the next activity pre-programmed for the student, or allows the instructor to select the next activity from a list of pre-programmed next activities.

q. On-Off Freeze. A control on the trainer which allows the instructor to turn on or off the pre-programmed freeze instructions within the trainer, or to freeze the trainer in a given state when a freeze is not pre-programmed. A

freeze shall cause all displays, controls, indicators, etc. to remain fixed in their position at the moment of the freeze.

Line Replaceable Unit (LRU)

A part of a system or subsystem with a function of its own, designed to be removed from the system or subsystem without being disassembled. It is the smallest unit to which a malfunction can be isolated by the O-level maintenance personnel.

Mnemonic

A device intended to assist memory. A word composed of initials standing for the successive steps of some process.

Negative Transfer

A condition where previous learning and/or habits of the target population interfere with the learning of new knowledge and/or the performance of new skills.

Noise

Irrelevant characteristics of an environment which can mask the properties of a stimulus.

Part-Task

A segment or part of a task. It typically does not have a goal or mission of its own and only takes on meaning in light of the entire task.

Positioning and Serial Movement

Positioning switches, pushbuttons, knobs, levers, etc., either individually or in a chain of highly coordinated motor tasks. May require precision. Motor aspects of equipment set-up and operating procedures.

Pre-programmed

When an instructional feature or capability is labeled pre-programmed, it means that the capability is controlled automatically by the trainer and requires no input from the instructor.

Problem-Solving

Making a decision based on limited information. Solving a novel problem by combining previously learned rules or generating new rules through trial-and-error.

Recalling Facts and Principles

Remembering and maintaining knowledge or nomenclature, functions, and physical laws. Relating basic knowledge through mental rehearsal or verbal or written recall.

Recalling Procedures

Recalling sequences of required behaviors in a specified order.

Repetitive Movement (Manipulations)

Repetitive or standardized behaviors, mechanical skills. Emphasizes dexterity, occasionally strength and endurance, requires low level of a larger task.

Response

Any objectively identifiable bodily action or behavior.

Rule Using

Applying a rule to a given situation by responding to a class input with a class of actions. Relating two or more simpler concepts in the manner of a rule. A rule states the relationships among concepts. It is helpful to think of principles as "if, then" statements.

Shaping

The process of gradually molding a desired behavior through successive approximations of that behavior.

Shop Replaceable Unit (SRU)

A part of a subsystem or a part of an LRU, with a function of its own. It is the smallest unit to which a malfunction can be isolated by I-level maintenance personnel.

Simulator

An analog; a device allowing the reproduction of events or situations that actually occur or exist.

Stimulus

Any event which acts as a cue for initiating behavior.

Signal-to-Noise Ratio

The proportion of true message (signal) to amount of interference (noise). Think of a telephone message, where the signal is the voice of the speaker and where the noise is the static or interference on the line heard by the listener.

Subsystem

Part of a system, when the system is comprised of two or more parts. A subsystem has a purpose and function of its own and is designed to interact with its peer subsystems in order to attain the purpose or mission of the system.

System

An assemblage comprised of interrelated and interacting subsystems designed to attain a predetermined purpose, e.g., the flight control system of an aircraft.

Target Population

The population of students who will use the maintenance trainer to attain the specified objectives and/or to acquire and/or practice the specified tasks and part-tasks.

Task

A statement describing the activities a performer must complete to attain a specific goal or mission. The statement at a minimum contains a verb describing the action taken and an object to which the action is addressed.

APPENDIX A

MEDIA CLASSES

Cassette Tape

Advantages

- Production and program reproduction are economical and distribution is convenient.

Disadvantages

- Fixed rate of information flow.
- Determining pace of material may be difficult.
- When audio alone is used student attention may begin to wander.
- Revisions require new master and can be time-consuming and costly.

Support Equipment

- Tape player, compact, portable, and generally easy to use.

Objectives

- Can be used to teach recognition or discrimination of auditory stimuli, such as sounds used in identifying machine malfunctions.
- Useful in drills for practicing responses to alarms or other auditory emergency signals.
- Can be combined with other print and/or actual equipment.
- Note that audio presentation leaves the eyes and hands free for other tasks. Audio can direct attention to aspects of visuals or equipment so that student can be led through complex procedures and trace complex signal flows.

PRINT

Graphics
(Diagrams, photo print series, graphs, charts, maps)

Advantages

- Permit close-up, detailed study at individual's own pacing.
- Easily distributed, revised, updated, or resequenced; complete flexibility of presentation.

Disadvantages

- Printing time production delay.
- Colored art work may be expensive.
- Presentation of movement not possible.

Support Equipment

- None

Objectives

- Reinforce the comments of an instructor through the use of visual representations of work flow or tabled/graphed numerical values.
- Present a visual outline of main lecture points or subdivisions.
- Provide factual information such as policies or procedures.
- Show spatial, hierarchical, or sequential relationships.
- To teach recognition of objects; location of objects; discrimination of visual stimuli--
    - can contrast images sequentially or simultaneously; can exaggerate (enhance through color coding or enlargement) differences in objects; use cutaway views for presenting internal parts; present a model for static positioning.

PRINT

Printed Text
(Job manual, programmed text)*

Advantages

- Student can proceed at own pace.
- Easily distributed.
- Material may be retained by student for reference on the job.

Disadvantages

- Student must have sufficient level reading ability.
- Revision of text can be time-consuming.
- Extensive word copy can become boring to student.
- Printing time production delay.
- Presentation of movement not possible.
- Material easily lost, damaged, or stolen.

Support Equipment

- None

Objectives

- Provide factual information such as policies, procedures, tabled values, or equipment part location.
- Useful when limited instructor availability.
- Good for remedial instruction.

*Punchboards and Tab Techniques are printed devices permitting a student to indicate a response which is then immediately confirmed by an underlying answer key. Useful in teaching system facts or troubleshooting concepts, these aids are inexpensive and allow the student to pace himself or herself.

STILL VISUAL

Transparencies, Slides

Advantages

- Small size means easily stored and distributed.
- Easy to change and add new means, flexible and updated quickly.
- Can be used with either large or small groups.
- Rear screen viewing equipment, means ideal for individual use (with or without taped narration).
- Synchronized automatic slide advance and remote control advance options.
- Progressive display of information possible.
- Low production cost, even for color representations.

Disadvantages

- Slight preparation interval delay.
- May require significant lighting reduction and thus restrict other activities in room.
- Technical preparation requirement.
- Presentation of movement not possible.
- Keystone distortion of images possible.

Support Equipment

- Projector, screen (remote control advance).

Objectives

- To teach recognition of objects; location of objects; discrimination of visual stimuli--
  - can contrast images sequentially or simultaneously; can exaggerate (enhance through color coding or enlargement) differences in objects; use cutaway views for presenting internal parts; present a model for static positioning.
  - show spacial, hierarchical, or sequential relationships.

STILL VISUAL

Filmstrips

Advantages

- Compact; easily handled and stored.
- No chance for incorrect ordering as is possible with slides.
- Are inexpensive when quantity reproduction is required.
- Are useful for group or individual study with projection rate controlled by instructor or user.

Disadvantages

- Fixed sequence reduces flexibility (rearrangement, replacement, updating).
- Longer preparation time than slides or transparencies
- Presentation of movement not possible.

Support Equipment

- Projector, screen.

Objectives

- To teach recognition of objects; location of objects; discrimination of visual stimuli--
  - can contract images sequentialy or simultaneously; can exaggerate (enhance through color coding or enlargement) differences in objects; use cutaway views for presenting internal parts; present a model for static positioning.
  - show spacial, hierarchical or sequential relationships.

SOUND/STILL VISUAL

Sound/Slide, Filmstrips*

Advantages	Disadvantages
• Depict motion to display system responses or model desired student responses.	• Production costs, time, and technical requirements vary depending on whether 8 or 16mm camera is used, and if extensive editing is required.

Support Equipment

- rojector, screen.

Objectives

- Slow motion and close-up photography allows detailed examination of system components or illustration of operator activities.
- Teach component location/identification, procedures.

*See STILL VISUAL - Filmstrips

AUDIO/VISUAL

Videotape, Sound Movie, Television

Advantages	Disadvantages
• Most appropriate for reaching large groups.	• Accurate synchronization of sound with visual materials.
• Playback capabilities.	• May require technical production skills; can be expensive.
• Motion portrayal possible (except slide/tape deck).	
• Student attention is retained.	

Support Equipment

- Screen, television, tape deck.

Objectives

- Teach recognition/discrimination of visual and auditory stimuli.
- Present model for student responses, procedure following.

COMPUTER ASSISTED INSTRUCTION

CRT, Terminal

Advantages

- Student can pace self.
- Lessons can be scored where storing of student responses is possible.

Disadvantages

- Original production and revisions are costly and time-consuming, with technical assistance necessary.
- Limited terminal availability necessitates scheduling of students.

Support Equipment

- Computer/Microprocessor.

Objectives

- Good for remedial instruction.
- Teach procedures, principles.

Three-dimensional equipment representations which may or may not use actual equipment components. Most are used to show component relationships or as procedures trainers.

Operating mockups use acutal or simulated equipment with components interconnected to function as when installed in actual operational locations.

Non-operating mockups generally are similarly arranged, and replicate actual equipment appearance but have no moving parts.

Cutaways contain components partially dissected to display internal appearance and/or functioning.

Animated panels are displays which depict system components pictorially or simple semi-functioning models constructed of plastic or wood. Interior or exterior views of components may be shown, and parts may be color coded or blown up in scale. Used to transmit information which will mediate the transfer of other skills or knowledge. As such, the use of real systems components may be undesirable at times where depicting the complexity of the components may interfere with the learning of basic interrelations.

Simulators include any device which allows the (total or partial) reproduction of work situations or events that actually exist or occur. The reproduction may be accomplished electronically and/or mechanically.

Advantages	Disadvantages
• Realistic portrayal of system parts and functions.	• Production, maintenance and updating of training hardware expensive and time consuming.
• Can teach many skills or knowledges on single trainer.	• Can present safety hazard; often noisy.

Support Equipment

- Computer.

Objectives

- Used to train complex motor skills; to teach location of parts; procedures for operation check-out or troubleshooting.
- Useful for demonstration purposes or to model working positions/ techniques for students.

APPENDIX B

LEARNING PRINCIPLE GUIDELINES

ASSOCIATING

DEFINITION: Involves having the student associate a symbol with a referent (meaning); e.g., associating a name with the function of a part.

PRACTICE SITUATION: The practice situation usually consists of presenting the student with a symbol and requesting an overt response. The behavior usually involves associating a list of symbols with a list of referents, presented individually or simultaneously. Normally associations, while used in later stages of the courses, are formally taught and practiced only early in training.

STIMULUS CONSIDERATIONS:

1. In the early stages of training you should highlight the symbol. Typically this can be done by increasing the intensity of the symbol or by decreasing the noise surrounding the symbol.

2. If time is a criteria, you will need to have control over the stimulus or symbol rate of presentation.

3. Any cue enhancement strategy should be reduced and withdrawn as learning continues.

RESPONSE CONSIDERATIONS:

1. To record responses student must make an overt response.

2. What to measure? Can measure or record the response, the accuracy of the response, or the speed of response.

3. What criterion level? the student should practice until he has reached a stabilized final criterion.

AUGMENTED FEEDBACK CONSIDERATIONS: Feedback considerations and conditions depend upon the stage of learning. Feedback must be reduced as training progresses.

EARLY STAGE:

1. Should concentrate on the accuracy of the response; speed of the response is reserved for the later stages.

2. Feedback should be given immediately after the student's response to avoid strengthening incorrect associations.

3. Feedback Message. Provide the student with the symbol and the correct referent, and if possible, indicate the reason why the student's response was incorrect.

LATE STAGE:

1. Usually reserved for time criteria, student should already be able to associate; practice is needed only to increase time or speed.

2. Feedback concerning time should be given immediately after the response. Be sure time frame is in proper unit (e.g., 50 responses within 2 minutes).

3. Feedback Message. Provide the student with his time and the criterion time. If the criterion is an index; e.g., correct response/time, be sure to give feedback in index form. If criterion is not time provide same kind of feedback as in the early stage.

NEXT ACTIVITY: After the feedback message is provided, the following activities are appropriate:

EARLY AND LATE STAGES:

1. If it is the first occurrence of the error, repeat the symbol some time during the practice session.

2. If student has made same error repeatedly, remedial instruction is required.

OTHER CONSIDERATIONS:

1. It may be helpful to have the student associate a mnemonic with the referent. If this option is selected, the student will need practice in associating the mnemonic with the referent.

2. In-the-head practice is helpful.

3. Self-initiating and self-paced practice is helpful, i.e., student controls when he practices and controls rate of presentation.

4. To prevent decay the student needs to practice associating throughout the course; e.g., refresher training may be needed, unless the association is already a component of later course exercises.

RECALLING PRINCIPLES AND FACTS

DEFINITION: Involves having the student recall facts or principles, e.g., Ohm's law, relationship between system input and output. (Also, recalling the location of a procedure in a technical manual.)

PRACTICE SITUATION: The practice situation usually consists of presenting the student with a stimulus (cue) and requesting an overt response indicating knowledge of the fact or principle. The cue should be withdrawn later. Usually there are many cues and facts and principles.

STIMULUS CONSIDERATIONS:

1. In the early stages of training you should highlight the cue or stimulus prompting the recall of the fact or principle. This is called cue enhancement. This can be done by increasing the intensity of the cue or by decreasing the noise surrounding the cue.

2. If time is a criterion, you need to control the rate of presentation of the cue.

3. Any cue enhancement strategy should be withdrawn as learning continues.

RESPONSE CONSIDERATIONS:

1. To record responses student must make an overt response.

2. What to measure? Can measure or record the response, the accuracy of the response, or the speed of response. Speed of response is usually not critical.

3. What criterion level? The student should practice until he has reached a stabilized final criterion.

AUGMENTED FEEDBACK CONSIDERATIONS: Feedback considerations and conditions depend upon the stage of training.

EARLY STAGE:

1. Should concentrate on the accuracy of the response and reserve speed of response for a later stage.

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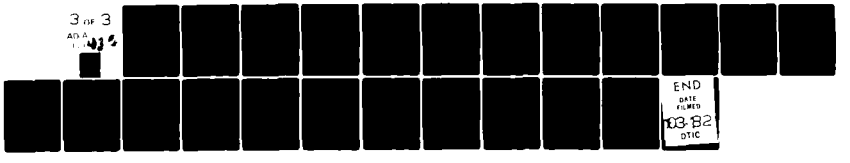
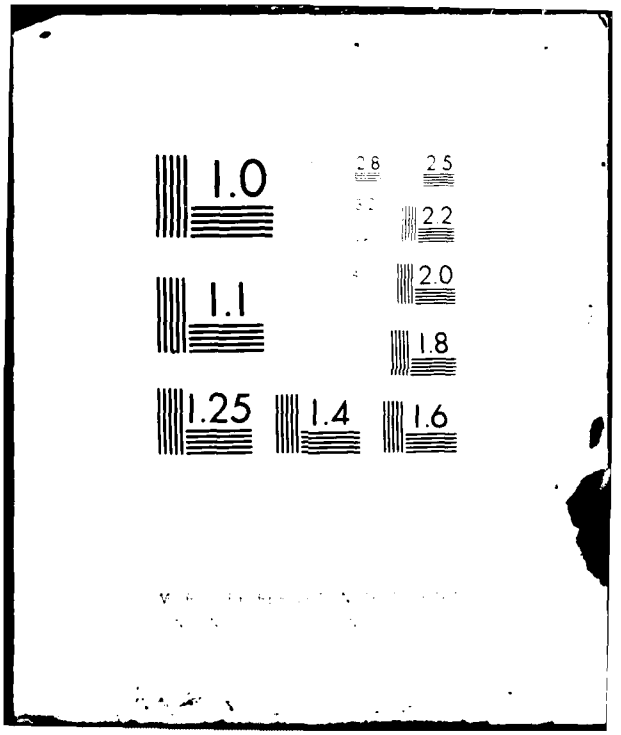
UNCLASSIFIED AFHRL-TP-81-51 NL

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2. Feedback should be given immediately after the student's response.

3. Feedback Message. Provide the student with cue and correct recall of fact or principle. If possible explain why student's response was incorrect.

LATE STAGE:

1. Usually reserved for increasing speed of response, if time is a criterion.

2. Feedback in the later stage should also be immediate.

3. Feedback Message: If time is the concern, the feedback message should provide the student with his time and the criterion time. If accuracy is the concern, provide the student the cue and the principle and fact. You can begin to reduce the type and kind of feedback.

NEXT ACTIVITY: After the feedback message is provided the following activities are appropriate:

EARLY STAGE:

1. If it is the first occurrence of the error, repeat the problem with a novel variation; i.e., change the content and form of the basic material to be recalled.

2. If the student has made the same error repeatedly, remedial instruction is required.

LATE STAGE:

1. If the concern is response time, have student repeat the recall session or problem until criterion time is reached.

2. If accuracy is the concern:

   a. If it is the first occurrence of the error, repeat the problem with a novel variation; i.e., if possible change the content and form of the basic material to be recalled.

   b. If student has made the same error repeatedly, provide remedial instruction.

OTHER CONSIDERATIONS:

1. It is helpful to have the student associate a mnemonic with the fact or principle to be recalled.

2. To increase the meaningfulness of the material, provide the student with flow charts, diagrams, or other aids to establish the relationship among the facts or principles.

3. To prevent decay provide refresher training as training continues; i.e., reschedule problem exercises sometime during the learning period, unless the fact or principle is applied or used in later course exercises. During refresher training try to present the problem(s) with a variation in content and form.

RECALLING PROCEDURES

DEFINITION: Involves having the student recall procedures; e.g., recall equipment assembly and disassembly procedures, recall operation or check-out procedures.

PRACTICE SITUATION: The concern is to have the student recall, but not actually perform the steps or procedures. The practice situation should provide the student with an opportunity to chain steps or events in the procedures. A cue should be provided for each step as well as for chaining the steps. Cues are withdrawn as learning continues.

STIMULUS CONSIDERATIONS:

1. Provide highlighting of the cues for each step.
2. Provide highlighting of the cues used to chain the steps.
3. Later in training begin to reduce the level of aiding (i.e., high, medium, low cue enhancement control).
4. Optional. Instead of highlighting the cues the responses can be highlighted. Reduce the level of response enhancement as training continues.
5. If time is a critical factor in measuring, you will need control of the rate of cue presentation.

RESPONSE CONSIDERATIONS:

1. To measure or record the response the student must make an overt response.
2. What to measure? Can measure or record the response, the accuracy of the response (e.g., are the steps performed or recalled in the proper sequence), or the speed of the response.
3. What criterion level? The student should practice until he has reached a stabilized final criterion level.

AUGMENTED FEEDBACK CONSIDERATIONS: Feedback considerations and conditions depend upon the stage of training.

EARLY STAGE:

1. Usually concerned about the accuracy of the response.

2. Feedback should be given immediately after the student's response on step recalled. As training progresses feedback should be delayed; e.g., after every two steps, after three steps, etc.

3. Feedback Message. The purpose of the feedback is error identification. Provide the student with the correct recall sequence. Also provide him with information concerning why the sequence must be maintained. If possible point out the consequence of the incorrect response.

LATE STAGE:

1. Usually concerned about time or about recalling the steps or procedures under unusual situations or conditions, e.g., introducing malfunctions.

2. Feedback should be delayed; i.e., provide feedback after every four or five steps or after the entire procedure has been recalled. Eventually reduce feedback to the operational setting if time is the critical factor, then provide the student with his time, plus the criterion time.

3. Feedback Message. The purpose of the feedback is error identification. Provide the student with the correct recall sequence. Provide the student with information concerning the consequences of the error.

NEXT ACTIVITY: After the feedback message is provided the following activities are appropriate:

EARLY STAGE:

1. If it is the first occurrence of the error, provide the feedback message and resume the problem. The problem may be started from the beginning to facilitate the chaining of the step. Time considerations may require restarting from an intermediate point. In any case, the step immediately preceding the error should be repeated.

2. If the student repeatedly commits the same error, then remedial instruction is appropriate.

LATE STAGE:

1. If it is the first occurrence of the error, provide feedback message but do not provide the corrective action. Give the student the opportunity to correct the error and continue the problem or exercise. Make sure the consequence of the error is noted.

2. If the student continually makes the same error, remedial instruction is appropriate, e.g., rehearsal of the procedure from the beginning.

3. Optional. You may elect to freeze the system after two procedural errors are noted. After the freeze, remedial instruction or continuation of same problem is appropriate.

4. If time is the critical factor, have the student practice until criterion time is reached, i.e., repeat the same problem exercise.

OTHER CONSIDERATIONS:

1. Provide the student with a checklist or other mediators to aid in the recalling behavior.

2. Provide the student with practice in associating the mnemonic with the procedural step.

3. Before practice in recalling, it is helpful for the student to see a demonstration.

4. Provide refresher training throughout the course, except where procedures are actually rehearsed or carried out later in the course. Provide practice with novel variations in content and form of the basic material to be recalled.

DISCRIMINATING

DEFINITION: Involves having the student discriminate between two or more objects or events, e.g., determining if two sounds are the same or different.

PRACTICE SITUATION: The practice situation usually consists of presenting the student with at least two stimuli. Early in training the two stimuli should be maximally different. As training continues the difference between the two stimuli is gradually lessened.

STIMULUS CONSIDERATIONS:

1. Early in training reduce the noise of the stimuli; that is, highlight the characteristics of the two stimuli that are critical in determining the difference. This implies that you will need a control to manipulate the signal-to-noise ratio. The signal-to-noise ratio can be manipulated by highlighting the characteristic of the stimuli or by reducing the noise.

2. Late in training begin to increase the signal-to-noise ratio to the operational level. Notice that the aiding level is reduced as training progresses.

3. If time is a consideration, you will have control over the rate of stimuli presentation.

RESPONSE CONSIDERATIONS:

1. To record or measure the response the student must make an overt response.

2. What to measure? Can measure or record the response, the accuracy of the response, or the time or speed of the response.

3. What criterion level? The student should practice until he has reached a stabilized final criterion.

AUGMENTED FEEDBACK CONSIDERATIONS:

EARLY STAGE:

1. Should concentrate on the accuracy of the discrimination response; time should be reserved for a later stage of training.

2. Feedback should be given immediately after each response.

3. Feedback Message. After the response, provide the student with information concerning the correctness of his response. This is usually done by showing the student the entire set of stimuli characteristics of both objects or events being discriminated; it should be recalled that early in training the characteristics making the two stimuli different are highlighted. In some cases it may be important to inform the student of the consequences of his errors.

LATE STAGE:

1. Usually concentrate on the time of the discrimination and not the accuracy (accuracy training mastery is assumed). If accuracy training is the key element then the problems presented are more difficult - the two stimuli begin to appear more similar.

2. Feedback should be given immediately after each response.

3. Feedback Message.

   a. If time is the concern, provide the student with his time, plus the criterion response.

   b. If accuracy is the concern, provide the student with the complete set of stimuli characteristics.

NEXT ACTIVITY: After the feedback message is provided the following activities are appropriate:

EARLY STAGE:

1. If it is the first occurrence of the error; then provide the student with another discrimiantion involving two other stimuli - repeat the incorrect discrimination later in the same practice session.

2. If the student repeatedly makes the same error then remedial instruction is appropriate - the remedial instruction should consist of noting the major characteristics of the stimuli.

LATE STAGE:

1. If time is the concern, provide the student with another opportunity to increase his speed. Vary the problem format and context.

2. If accuracy is the concern, provide the student with another problem - repeat the problem in which the error occurred later during the same session.

OTHER CONSIDERATIONS:

1. It would be helpful to give the student a list of the important characteristics. In addition, a procedure for looking at the characteristics (order), if possible, would be helpful.

2. Provide refresher training of more difficult problems later in training, unless the discrimination is practiced as part of a later course exercise.

CLASSIFYING

DEFINITION: Involves classifying an object or event into a pre-defined category. This behavior is not problem solving or rule using.

PRACTICE SITUATION: The practice situation usually consists of presenting the stimuli and requesting a response indicating the class the stimuli belongs to. Problems are made more difficult by increasing the signal-to-noise ratio of the stimuli being presented.

STIMULUS CONSIDERATIONS:

1. Early in training decrease the signal-to-noise ratio; as learning progresses increase the signal-to-noise ratio. This can be accomplished by increasing the intensity of the irrelevant characteristics.

2. If time is part of the criteria, you need control over the rate of presentation.

RESPONSE CONSIDERATIONS:

1. The student must make an overt response.

2. What to measure? Can measure or record, the response, the accuracy of the classification response, or the time or speed of the response.

3. What criterion level? The student should practice until he has reached a stabilized final criterion.

AUGMENTED FEEDBACK CONSIDERATIONS:

EARLY STAGE:

1. Usually concerned with the accuracy of the response; time is usually reserved for later stages of training.

2. Provide feedback immediately after the response.

3. Feedback Message. The purpose of the feedback is error identification. Provide the student with the full set of stimuli that are required to classify the object or event. In some cases it may be important to provide the student with information concerning the consequences of the error.

LATE STAGE:

1. Usually concerned with time or with accuracy (if accuracy, the problems are more difficult; i.e., the signal-to-noise ratio is higher than during the initial stages of training).

2. Provide feedback immediately after the response.

3. Feedback Message.

    a. If time is the concern, provide the student with his time plus the criterion time.

    b. If accuracy is the concern, provide the student with the full set of stimuli characteristics.

NEXT ACTIVITY: After the feedback message is provided the following activities are appropriate:

EARLY STAGE:

1. If it is the first occurrence of the error:

    a. Present the student with another problem, a different classification problem using the stimuli that were classified incorrectly, later in the same training session.

    b. Present the same classification problem, but decrease the irrelevant cues.

2. If the same error occurs repeatedly, provide remedial instruction. The remedial instruction should provide a review of the critical characteristics of the object or event being classified.

LATE STAGE:

1. If time is the concern, provide the student with an opportunity to practice again. May consider changing the content and form of the problem; i.e., increasing the signal-to-noise ratio.

2. If the concern is accuracy:

   a. If it is the first occurrence of the error, present the student with a different classification problem or repeat the problem later during the same session, but decrease the irrelevant cues.

   b. If the student makes the same error repeatedly, remedial instruction is appropriate. The remedial instruction should provide a review of the classification characteristics.

OTHER CONSIDERATIONS:

1. Early in training provide the student with an aid which lists the major characteristics of the class.

2. Provide refresher training of the most difficult problems; i.e, those with a high level of noise to signal, unless the classification is practiced as part of later course exercises.

RULE USING

DEFINITION: Involves applying a rule in a given situation; e.g., if situation "A" then "B" applies.

PRACTICE SITUATION: The practice situation emphasizes the logical relationship between the general principle and the specific application of the principle. The unique or special features of each application should be minimized while the common relationships to the general principle should be emphasized. The practice situation should be varied; i.e., the student should be given a wide variety of situations in which the same principle is applied.

STIMULUS CONSIDERATIONS:

1. Highlight those characteristics of the situation which relate to the general principle; minimize the special features of the specific situation. That is, highlight the relevant cues early in training. This implies that you will need control over the signal-to-noise ratio. The cues should be withdrawn as training progresses.

RESPONSE CONSIDERATIONS:

1. Student must make an overt response.

2. What to measure? Can measure or record the response, the accuracy of the response, or the speed of the response. Be aware that rule using involves both process and solution. The accuracy of the process as well as the solution may be considered.

3. What criterion level? The student should practice until he has reached a stabilized final criterion.

AUGMENTED FEEDBACK CONSIDERATIONS:

EARLY STAGE:

1. Usually concerned with accuracy of solution and process; time or speed is usually reserved for later stages.

2. Feedback should be given immediately after each response.

3. Feedback Message. The purpose of the feedback is both error identification and the consequences of the error. Provide the student with correct response, explaining why his response was incorrect as well as the consequences of his responses.

LATE STAGE:

1. Usually concerned with speed of application.

2. Provide the student with immediate feedback.

3. Feedback Message.

   a. If time is the concern, provide his time as well as the criterion time.

   b. If accuracy (both process and solution) is the concern, provide the student with information concerning why his response was in error. Be sure to provide him with information concerning the consequences of his error.

NEXT ACTIVITY: After the feedback message is provided the following activities are appropriate:

EARLY STAGE:

1. If it is the first occurrence of the error, present the student with a problem situation which is similar (i.e., one involving the same principle).

2. If the student makes the same error repeatedly, remedial instruction is appropriate. The remedial instruction should provide the student with information concerning the rule and its application.

LATE STAGE:

1. If time is the concern, provide the student with a similar problem; i.e., one involving the same rule. Be sure it is not the same problem, but one that is similar.

2. If accuracy is the concern:

   a. If it is the first occurrence of the error, then present a problem which is similar.

b. If error occurs repeatedly, remedial instruction is appropriate. The remedial instruction should provide the student with information concerning the rule and its application.

OTHER CONSIDERATIONS:

1. Use system flow charts, diagrams or other means, to establish the relationship between the general principle and the specific application.

2. System parameters can be varied to make different problems involving application of the same principle.

3. It is necessary to provide the student with a wide variety of situations in refresher training. Use of rules may be incorporated in later course exercises such as problem solving.

PROBLEM SOLVING

DEFINITION: Involves choosing a course of action when alternatives are unspecified or unknown, or when the penalties for an unsuccessful course of action are not readily apparent. Sometimes the relative value of possible decisions must be considered, including possible tradeoffs.

PRACTICE SITUATION: The practice situation usually consists of presenting a problem and asking for a decision. The student should be presented with a wide variety of situations requiring problem solving skill (i.e., easy as well as difficult problems). Problems can be made easy or difficult by controlling the amount of information presented to the student. In the final stages of training the student should be provided with only the limited data available in a real world situation.

STIMULUS CONSIDERATIONS:

1. Early in training provide the student with more pertinent information to make the decision than actually received on the job. As training progresses, gradually decrease the amount of information. In the final stages of training provide the student with a realistic information processing load.

   An alternative is to restrict the information given early in training to only that which is actually needed to make a simple decision. As training progresses gradually increase the information as the problems become more difficult. However, in the final stages of training provide the student with a realistic information processing load (both in signal and noise).

2. If decisions have to be made quickly and time is a factor, you will need control over the rate of presentation of information.

RESPONSE CONSIDERATIONS:

1. The student must make an overt response.

2. What to measure? Can measure or record responses, accuracy of the response, or speed or time of the response. Be aware that problem solving involves both process and solution. The accuracy of the process as well as the solution may be considered. There should be provisions made for recording an intermediate alternative when it is identified as well as recording the final alternative (the overall choice selected).

3. What criterion level? The student should practice until he has reached a stabilized final criterion.

AUGMENTED FEEDBACK CONSIDERATIONS:

EARLY STAGE:

1. Feedback should be given immediately after the response. The early stages should be concerned with simple problems.

2. Feedback Message. Provide the student with information concerning both process and solution. The single alternative should be evaluated against standard criteria. That is, he should be presented with the logical implications of the alternative choice. Thus the student should be provided information when an alternative is identified. He should be provided with information concerning the merit of the final alternative selected when the choice is made. That is, the feedback should consider giving the student information which compares all the identified solutions or alternatives.

LATE STAGE:

1. Delay the feedback, until the final choice among the alternatives is made.

2. Feedback Message. Provide the student with information concerning the comparison of the selected alternative against all the competing alternatives. Be sure to communicate the consequences of his selection.

NEXT ACTIVITY: After the feedback message is provided the following activities are appropriate:

EARLY STAGE:

1. Provide the student with a similar but different problem; i.e., change the context of the stimuli. Remedial instruction may be needed if the same error is made repeatedly.

LATE STAGE:

1. Provide the student with a similar but different problem; i.e., change the context of the stimuli.

2. Optional. A freeze may be effective if the decision-making is lengthy and complex. A freeze should occur only if an alternative is selected which would result in danger to equipment or personnel. After the freeze the following next activities are appropriate:

    a. Allow the student to select another alternative and continue the problem. This should ingrain the consequences of a faulty decision, as well as point out why the initial decision was faulty.

    b. Restart the problem from the beginning. In this way the student can track his error and possibly avoid making the same error in the future.

    c. Select a similar problem (i.e., use a different stimulus context.

OTHER CONSIDERATIONS:

1. Use the principles of time compression (i.e., artificially move the situation ahead to point out the major ramifications of the alternative choices, so that alternative choices can be compared).

2. Use mediators such as stereotypes to artificially facilitate the identification of response alternatives and the probability of success of each alternative.

3. If stress is a factor in the decision-making, use the principle of overlearning to minimize the effect of competing responses.

4. Provide refresher training on the most difficult problems. Problem-solving training exercises may incorporate discriminating, classifying, recalling, and using rules learned earlier.

POSITIONING AND SERIAL MOVEMENT

DEFINITIONS: Involves positioning switches, knobs, levers, etc., either individually or in sequence. Usually involves highly coordinated motor activity where system feedback is important.

PRACTICE SITUATION: The practice situation usually consists of having the student practice the motor activities involved in their proper sequence. One of the major principles involved is "shaping"; i.e., the feedback given to the student should be contingent upon the characteristics of the student's responses, so that by the process of "successive approximations" the final desired proficiency is produced.

STIMULUS CONSIDERATIONS:

1. Early in training it may be necessary to highlight cues on stimuli and sometimes it is necessary to highlight responses. However, because the behavior involves motor movement, you should emphasize the development and use of internal cues and cues of "feeling."

2. All external cues need to be withdrawn.

RESPONSE CONSIDERATIONS:

1. The student must make an overt response.

2. What to measure? Can measure or record the response, the accuracy of the motor activity, the time or speed of the movement(s), and the smoothness of the motor activity.

3. What criterion level? The student practices until the final desired proficiency is obtained.

AUGMENTED FEEDBACK CONSIDERATIONS:

EARLY STAGE:

1. Usually concerned with the accuracy of the motor activity; time or speed reserved until the later stages of learning, as is smoothness.

2. In the early stages of learning immediate feedback is usually provided; however, the principle of shaping can be used. If shaping is used, then the criteria against which the student's response is compared must be adjusted for each student and thus the feedback schedule may change.

3. Feedback Message. The purpose of the feedback is error identification. Provide the student with information concerning the accuracy of his performance and compare his performance to the criteria.

LATE STAGE:

1. Usually concentrates on speed and smoothness.

2. The feedback is usually delayed until the student completes the entire motor skill.

3. Feedback Message. Inform the student of his speed and/or smoothness score. Also compare his score to the criteria. If the principle of shaping is used, the criteria will be changing at almost every practice session.

NEXT ACTIVITY: After feedback is provided the following activities are appropriate:

EARLY AND LATE STAGES:

1. Always have the student practice the same situation until it is mastered. However, if shaping is used, mastery will be defined differently each time the student practices.

OTHER CONSIDERATIONS:

1. Provide recall training prior to or concurrent with motor training.

2. Before practice provide the student with a demonstration, preferably from the operator's perspective.

3. Provide refresher training throughout the course.

CONTINUOUS MOVEMENT

DEFINITION: Involves tracking and dynamic control; involves perceptual motor activity (e.g., continuous pursuit of a target or keeping dials at a certain reading). Also may involve the scanning of complex displays to determine the status of the system and/or predict the evolving state of the system.

PRACTICE SITUATION: The practice situation usually consists of having the student practice the continuous movement involved. Repetitive practice is needed for the student to master the movements. During the practice stages or sessions the student should be exposed to a wide variety of problems where the movement is involved. In this way he will begin to learn the control and display relationships or be able to estimate the changes in the system. The principle of "shaping" is also used.

STIMULUS CONSIDERATIONS:

1. Provide cues which indicate the effect of the movement of the system; these enhancements can also be used as feedback.

2. Withdraw the cues as the student progresses through training.

RESPONSE CONSIDERATIONS:

1. The student must make an overt response.

2. What to measure? Can measure the response or the movement, the accuracy of the movement, the speed or time of the movement, and smoothness of the movement (e.g., over-correcting or undercorrecting movements).

3. What criterion level? The student should practice until the final proficiency level is reached.

AUGMENTED FEEDBACK CONSIDERATIONS:

EARLY STAGE:

1. Usually concerned with the accuracy of the movement.

2. Because of the dynamic nature of the problems, the trainee should be presented with an on-going evaluation of his performance. Thus, immediate feedback should be given after every movement; this feedback, however, need not be augmented feedback (it may be intrinsic feedback).

3. Feedback Message. Inform the student of the effect of his movements on the system. If possible use predictive displays (e.g., what will occur 12 seconds in the future). Compare the student's performance to the criteria.

LATE STAGE:

1. Usually concerned with speed and smoothness.

2. Feedback should be delayed until the whole problem or exercise is completed.

3. Feedback Message. Compare the student's performance to the criteria; if shaping is used the criteria may be different at each practice session.

NEXT ACTIVITY: After the feedback message is provided the following activities are appropriate:

EARLY AND LATE STAGES:

1. Have the student practice the same movement but in a different context; i.e., the same type of control or adjustment is made but in a different context. As the student masters a simple problem progress to the next level of problem difficulty; i.e., more precise control movements. Use the principle of shaping.

OTHER CONSIDERATIONS:

1. Provide for the development and use of predictive-type self-instructional and anticipating cues.

2. Provide refresher training throughout the course. Where possible use tasks incorporating several of the continuous movement skills being trained.

REPETITIVE MOVEMENT

DEFINITION: Involve manual dexterity, occasionally strength and endurance. Often this is only a component of a large task.

PRACTICE SITUATION: The practice situation usually involves having the student practice the repetitive movements. The student should practice the same thing continuously to take advantage of the built-in feedback properties of this type of behavior. The principle of "shaping" should be used.

STIMULUS CONSIDERATIONS:

1. Typically none are required; if possible provide hints which help the student to identify for himself the difference between correct and incorrect performance.

RESPONSE CONSIDERATIONS:

1. The student must make an overt response.
2. What to measure? Can measure or record the response or movement, the accuracy of the movement, the time or speed of the movement, and the smoothness of the movement.
3. What criterion level? The student should practice until mastery is reached.

AUGMENTED FEEDBACK CONSIDERATIONS:

EARLY STAGE:

1. Usually concerned with the accuracy of the response.
2. Feedback should be immediate.
3. Feedback Message. Inform the student of the correctness of his response, provide him with information so that he can discriminate between the correct and incorrect movements - the best feedback is the built-in feedback - "muscle feel."

LATE STAGE:

1. Usually concerned with time or smoothness.

2. Feedback schedule should be delayed.

3. Feedback Message. Provide the student with information concerning his performance compared with the criteria; the criteria may change in each practice session.

NEXT ACTIVITY: After the feedback message is provided the following activities are appropriate:

EARLY AND LATE STAGES:

1. Practice on the same problem until mastery is reached. Because of shaping, the criteria level desired may change from practice session to practice session.

OTHER CONSIDERATIONS:

1. The student practices repetitively. However, to reduce the effects of fatigue in learning motor skills and to minimize the effects of competing responses, provide periods of rest.

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